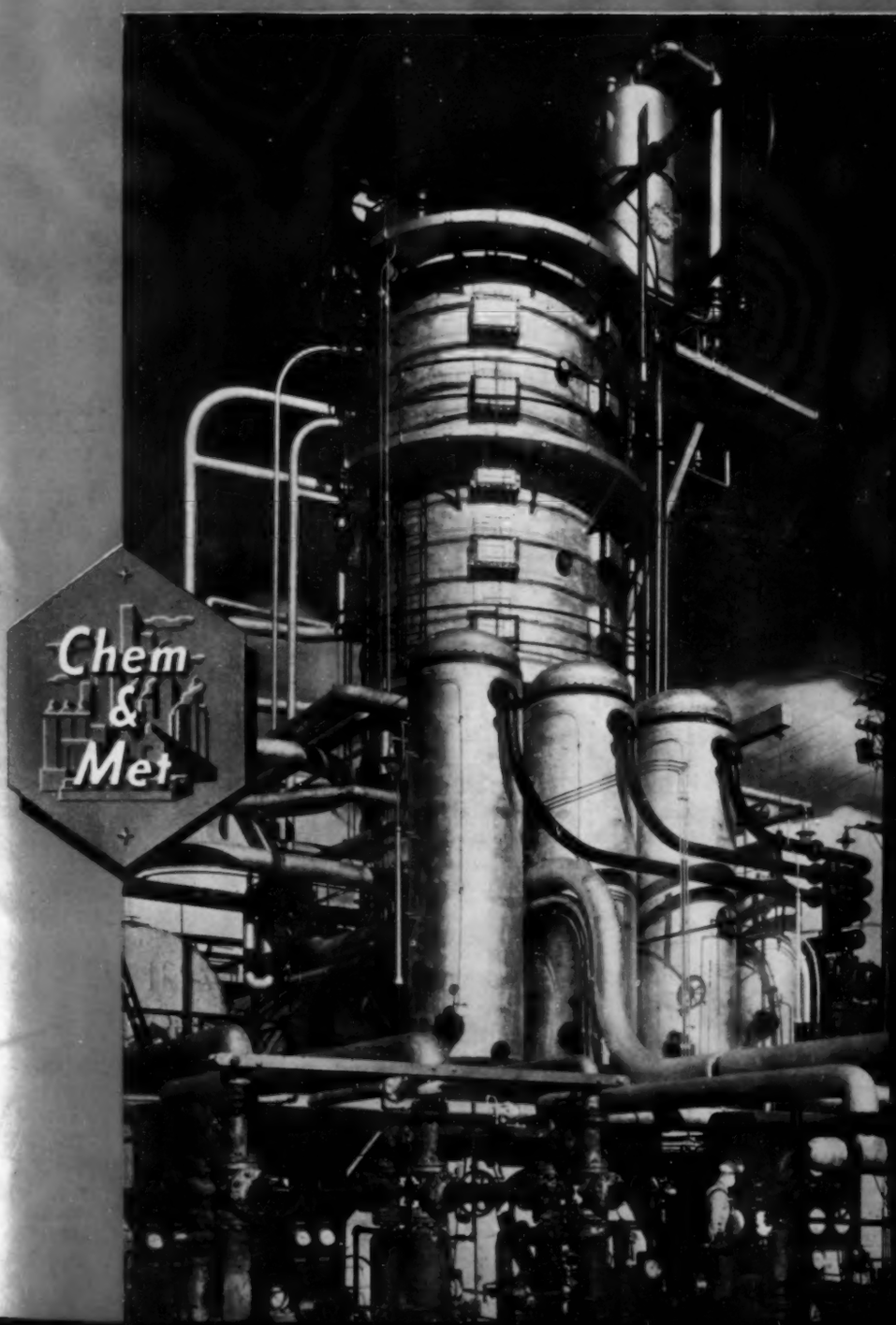
CHEMICAL & METALLURGICAL ENGINEERING



SEPTEMBER, 1942

MATERIALS...MATERIALS ...MATERIALS!

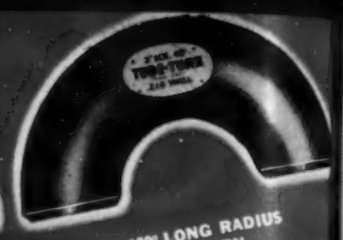
That one word is uppermost in all our minds as the war production program is pushed for peak performance. More and more critical and strategic materials of construction are needed not only in ships, tanks and planes but also to build more plants and equipment to produce more aviation fuels, synthetic rubber, block-busting explosives, incendiaries and other chemical munitions. So important is this to chemical engineers today that Chem. & Met. devotes its Tenth Materials of Construction issue to solving such problems as these: (1) How to make equipment last longer. (2) How to get and use substitutes for scarce materials. (3) With what can we build for the future after the present job is done? Today's challenge, if we meet it with new and improved materials and processes, is Tomorrow's victory.

WASHINGTON NEWS pp. 162-163

Types, Sizes and Weights for Every Pipe Welding Need

TUBE-TURN
WELDING FITTINGS

180° SHORT RADIUS RETURN



180° LONG RADIUS RETURN

180° EXTRA LONG RADIUS

90° LONG RADIUS ELBOW

90° SHORT RADIUS ELBOW

45° LONG RADIUS ELBOW

STRAIGHT TEE

REDUCING OUTLET TEE

CAP

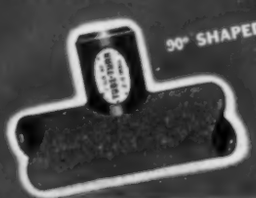
LAP JOINT STUB END

CONCENTRIC REDUCER

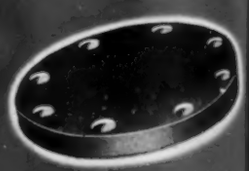
ECCENTRIC REDUCER

WELDING RING

STRAIGHT LATERAL


90° SHAPED NIPPLE

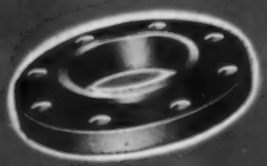
45° SHAPED NIPPLE


BLIND FLANGE

SADDLE

STRAIGHT CROSS

WELDING NECK FLANGE


SLIP-ON FLANGE

LAPPED FLANGE

SCREWED FLANGE

TUBE-TURN WELDING FITTINGS—RANGE OF SIZES

TYPE OF FITTING	DESCRIPTION	STANDARD WEIGHT	EXTRA STRONG	SCHEDULE 160	DOUBLE EXTRA STRONG
ELBOWS	90° LONG RADIUS	½"-24"	¾"-24"	1"-12"	1"-8"
ELBOWS	90° SHORT RADIUS	1"-24"	1½"-24"		
ELBOWS	45° LONG RADIUS	½"-24"	¾"-24"	1"-12"	1"-8"
RETURNS	180° LONG RADIUS	½"-24"	1"-24"	1"-12"	3"-8"
RETURNS	180° SHORT RADIUS	1"-24"	1½"-24"		
RETURNS	180° EXTRA LONG RADIUS	1"-2½"	1"-2½"		
TEES	STRAIGHT	¾"-24"	¾"-24"	1"-12"	1"-8"
TEES	REDUCING OUTLET	¾"-24"	¾"-24"	1"-12"	1"-8"
REDUCERS	Concentric and Eccentric	1x¾"-24x20"	1x¾"-24x20"		1x¾"-12x10"
CAPS		1"-24"	1"-24"		1"-24"
STUB ENDS	LAP JOINT	1"-24"	1"-24"		
NIPPLES	Shaped, 90° or 45° to Header	1¼"-12"	1¼"-12"		
SADDLES		2"-24"			
LATERALS		1¼"-24"	1¼"-24"		
CROSSES		1¼"-24"	1¼"-24"		
RINGS		¾"-12"	1¼"-12"		
		150, 300, 400†, 600 and 900* Lb.		1500 Lb.	2500 Lb.
FLANGES	WELDING NECK	½"-24"		½"-24"	½"-12"
FLANGES	SLIP-ON	½"-24"		½"-12"	½"-12"
FLANGES	LAP JOINT	½"-24"		½"-24"	½"-12"
FLANGES	THREADED	½"-24"		½"-12"	½"-12"
FLANGES	BLIND	½"-24"		½"-24"	½"-12"

† Dimensions on sizes thru 3½" same as for 600 lb. flanges.

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Chem & Met

NEXT MONTH

Catalysis, that potent factor upon which depend so many chemical processes and about which most chemical engineers know so little, will be the subject of next month's feature report. Both theory and practice will be discussed and applications to inorganic, organic, petroleum, and synthetic rubber technology will serve to illustrate some of the workings of chemistry's nearest approach to "something for nothing." The object of this report will be to summarize the present status of "catalytic chemical engineering," to indicate the role of catalysis in our war technology, and to point out possible new applications in industry.

McGRAW-HILL

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CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902

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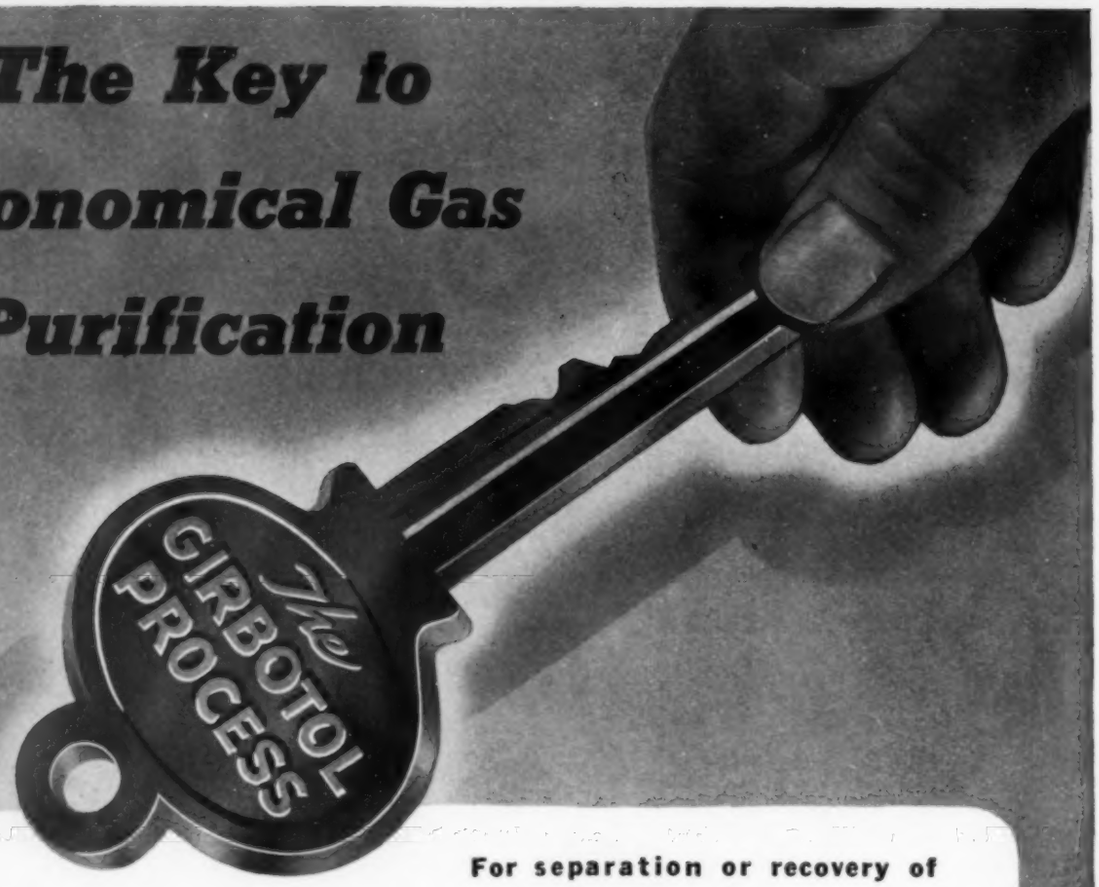

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CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902

S. D. KIRKPATRICK, *Editor*

SEPTEMBER, 1942

MATERIAL AND MATERIEL

BACK in the dismal days of the depression, we argued endlessly about whether our troubles were caused by over-production or under-consumption. Today when some essential war industries are being slowed down by inadequate supplies of raw materials, everyone is asking,—"Are these real shortages, or are we suffering temporarily from maldistribution and unbalanced inventories?" The answer, now just as it was ten years ago, is that it is academic to argue over nomenclature. We face, as we did then, a definite situation. We must make immediately the necessary corrections and adjustments so that we can get going again at the highest overall rate for the things we need most. That that means maximum production of war goods and absolute minimum of everything else, now goes without saying.

We know that we have not made the best use of our material resources in the past two years, but we have built a tremendous war industry in much shorter time than any other nation in the world. Time has been of the essence and we have had to fight for everything we needed to do the job assigned to us. The priority system itself encouraged competitive acquisitions. There have been too many top ratings for too little supply, particularly for steel and other critical construction materials. Is it any wonder that some inventories are badly unbalanced, that often substantial quantities of materials are tied up for want of one or two parts or products? We have heard reports of a million-dollar war project held up for want of $20,000 worth of alloy steels. Meanwhile other plants to supply complementary materials must shut down or mark time to keep from piling up "too much and too soon."

Donald Nelson, who has lately had to fight off his critics with his back almost to the wall, had the only common-sense answer. "The big job ahead of us right now," he said on August 22nd, "is to bring our program into balance and to make sure we use our materials and our facilities as wisely as possible." Whether such good advice is going to be followed voluntarily by industry is an open question. A workable system of inventory control through complete allocation of production requirements might be the answer. But when it comes to requisitioning and redistributing goods already in private hands, something more than general directives from Washington will be needed. Definite policies must be established and enforced by the government. Here is a job that calls for stronger, more direct action than any we have yet had from this administration.

One blind spot in many of our calculations is the large percentages of the output of certain raw materials that have been and are still going out of the country. This is part of a grand strategy, which apparently has the approval of the military authorities. Yet in cases where critical war production in this country is held up for want of materials being exported under Lease-Lend, it is obvious that we are not following that "wisest" course in utilizing our own great resources.

In our concern with the immediate situation, which we hope is already in the process of being corrected, let us not lose sight of the fact that we are in a period of transition to a different and more abundant materials economy. We are operating many basic industries at higher levels than ever before in history. We are just beginning to realize some of the advantages as well as limitations of a greatly expanded volume of business. For the first time we are seeing what our science and technology can do when the production engineer is given the right of way with the throttle wide open!

So, as we push ahead to produce the tremendous supplies of materiel required for our war effort, we may take some byproduct credit for helping to build a better post-war economy. In that process of meeting today's problems and preparing for tomorrow's, we hope that this Tenth Materials of Construction issue of *Chem. & Met.* will serve as a

useful and practical source of reference—both for information and inspiration. It tells many stories of material and materiel of which the chemical engineering profession may well be proud.

LIFE BEGINS

FORTY years is not very long in the history of American industry. Yet since Vol. 1 No. 1 of this magazine appeared as *Electrochemical Industry* in September 1902, its field has undergone significant changes. First there was the budding industry that sprang up around Niagara Falls as cheaper hydro-electric power first became available. Electrometallurgy followed closely on the heels of electrochemistry and in 1905 the field of the magazine was extended in that direction.

"Engineering" first became a part of our name in January 1910 because, said the editor, "we wish to emphasize that this journal is not, on the one hand, a trade paper, nor on the other hand a periodical representative of pure science. Rather, we are concerned with . . . what is needful in the work of the engineer in the conduct and management of . . . chemical works."

It is interesting to note that the same editorial forecast the unit-operation concept of chemical engineering when it remarked that all those "engaged in engineering practice in industrial establishments are more or less interested in the same processes—in crushing and grinding, concentration and separation, drying and evaporation . . . etc."

Chemical engineering arose to meet the challenge of the first World War and that ascendancy was duly noted July 1, 1918, when, "*Met. & Chem.*" became "*Chem. & Met.*" That was almost a quarter of a century ago. Today all of us are again faced with new problems and responsibilities. We on *Chem. & Met.* consider ourselves fortunate to be allied with a resourceful industry and profession that offers so many opportunities for serving our country in its present need. We are encouraged to believe with Professor Pitkin that "Life Begins at Forty."

GET IN THE SCRAP!

WALTER CARPENTER, able president of the du Pont company, is helping the American Industries Salvage Committee to carry its program into every company in the chemical industry. He has urged his fellow executives to get behind the work of the Industrial Salvage Section of W.P.B. "This is a situation," he said, "wherein by helping our Government, we are also helping ourselves; because industry cannot do a satisfactory job of production without more scrap materials than are normally available. . . There is needed an extraordinary cleanup of our factories, involving recognition of the fact that if a machine or pipeline, a heating plant, a building . . . is not absolutely essential for production at this time, then consideration should be given to scrapping it. If we don't win this war, most of our factories will be scrapped anyway!"

In 1,200 different communities, W.P.B. has set up general salvage committees. In 400 industrial centers there are representatives of its Industrial Salvage Section ready to help in organizing effective salvage work in factories, offices and laboratories. This assistance is yours for the asking. Write or wire the Conservation Division, War Production Board, Railroad Retirement Building, in Washington.

Washington Highlights

PRIORITY policies now pinch severely on research and control laboratories which use as much as $5,000 per quarter of scarce metals. This makes the laboratory director responsible for P.R.P. quarterly filings and the pursuance of the rest of the Preference Rating ritual. Obvious remedy is to adapt old facilities to new purposes in the lab as well as in the works, whenever this is possible, even with the sacrifice of a bit on efficiency.

CONCENTRATION of production in a few plants is to be extensively practiced in metal-working industries. There may be a few cases where this practice can be helpfully applied in the chemical industries. If a single producer has facilities to manufacture all the needed quantity of some chemical, there ought to be means by which anti-monopoly rules can be suspended to permit that efficient plan of operation, if it is really of benefit in saving skilled manpower. But long transportation and confusion in supply for essential users must not creep in as a secondary effect or the benefits of concentration of production will be overshadowed and the war program hurt rather than helped. Probably only a few chemical cases will really qualify for this program.

GUARANTEES of both quality and price for domestic soap supplies is undertaken in recent actions of O.P.A. One wonders how the quality of certain detergents can be guaranteed when almost essential raw materials like coconut oil are obviously not available. Maybe O.P.A. will provide some new laboratory technics to help the much buffetted soap experts. We wonder.

RECORD PRODUCTION of synthetic organic chemicals in 1941 is reported by the preliminary statistics of U. S. Tariff Commission, issued in mid-August. This division of the chemicals industry sold $724,000,000 worth of goods last year. This was an increase of 50 percent over the previous year's sales which had been the highest on record. The rate of growth and the adequacy of synthetic chemicals supply probably surprises no one, except, we believe, our Axis contemporaries.

NEW COSMETICS are virtually prohibited by the regulations restricting containers and the use of container materials. Comparable policy is suggested by W.P.B. actions on more important industrial materials. But fortunately there is no tendency to discourage new chemicals which have a real war-time service value.

CHEM & MET REPORT ON

Materials for the Construction of Chemical Engineering Equipment

The war is having a tremendous effect on all materials, in particular aluminum, stainless steels, nickel, copper, rubber, and others which the chemical engineer has become accustomed to specify for construction of his equipment. The source of natural rubber is in the hands of the enemy, stainless steels are in demand for ships, guns, and tanks; copper for shells; aluminum for airplanes; rubber for jeep tires and a thousand other uses. The process industries must share the supplies of these strategic materials. It is essential that the limited amounts be conserved and made to stretch as far as possible, that life of present equipment be prolonged throughout the period of the emergency, and that substitutes be used whenever practical. For the success of the Victory Program depends in no small measure on their availability for the construction of equipment so badly needed to swell the supplies of synthetic rubber, 100-octane gasoline, and chemical warfare agents for the armed forces. Chem. & Met.'s Tenth Materials of Construction Issue should serve a timely and useful purpose. It presents the ways and means for conserving and protecting materials and equipment. Its data sheets bring up to date the basic information on manufacturers, composition, and corrosion, heat and abrasion resistance. In effect, it is a complete mobilization of available information.

CHEMICAL AND METALLURGICAL ENGINEERING · SEPTEMBER, 1942

Materials of Construction for Today and Tomorrow

SUMMARY AND CONCLUSIONS

Realizing the seriousness of the present situation in materials for corrosion, heat and abrasion resistance, the editors in this report have suggested means by which engineers can get most out of what they now have. For the benefit of those who can not obtain the materials they would normally specify, the availability of substitutes or alternates is discussed. The world upheaval is necessarily having a tremendous influence on the entire field of materials and has called for a look at the materials of tomorrow.

Properties of metals and alloys are presented for the first time on a series of fold-out inserts for simplicity in handling. For each material are given the manufacturer's name and address, the composition, and resistance to abrasion, to heat, and to commonly encountered chemicals. The trend towards adoption of standard uniform nomenclature for all alloys has been given further inpetus by development of a system of designations for heat and corrosion resisting castings by the Alloy Castings Institute. The influence of the war is reflected in the tabulations of information on non-metallic materials. A vast new synthetic rubber industry is in the making and new plastics are available to the engineer for the first time.

Conservation of Materials

"THE CIVILIAN ECONOMY is fast going on a minimum subsistence standard, vital materials no longer can be used except for war, and for the maintenance of those things necessary to carry on the war. The past months have been relatively easy, the military has taken from the civilian to meet its needs. This pool is nearly dry, from here on out it will be a continuous problem to meet the needs of our fighting forces. Industry must get ready to 'Patch and Pray' to keep existing equipment at work," warns W. L. Batt, chairman of the Requirements Committee of WPB. Just as long as the emergency exists the metals and their alloys, with the exception of lead, which the chemical engineer has become accustomed to depend upon for the construction of his process equipment will be difficult to obtain unless he is fortunate enough to possess a high priority. This situation is not limited to the metallic materials, for rubber is in the same category. And while there are not the same restrictions on chemical stoneware, glass, wood, and the other non-metallic materials, nevertheless, the heavy demand makes delivery of new equipment slower than it is in normal times.

As Mr. Batt warned, the engineer must be resourceful in conserving the supplies of strategic materials and in prolonging the life of present equipment. When new equipment is planned much can be done to stretch the supply of strategic metals. In some instances this may be accomplished by specifying linings over a base metal. Probably the greatest conservation can be obtained by more careful study of each item, and use of the lowest possible alloys which are now in commercial production, as V. W. Whitmer recently stated before the A.S.T.M. For example, there are undoubtedly many applications using chromium-nickel alloys where the straight chromium could be very easily substituted.

Favorable design should be considered which will provide against the presence of crevices, pockets, or other areas that might promote accumulation of deposits or stagnant liquors. In cases where excessive corrosion at one or more points in a vessel has been troublesome it is well to examine carefully for the presence of those areas which might be responsible for this susceptibility to corrosion.

Excessive wear in vessels, pumps and piping frequently is due to inadequacies of design. Reduction in rates of flow, or slight changes in direction of flow, might be sufficient to reduce excessive wearing of piping and valves. Excessive wear of pump parts might be due to use of improper alloys for wearing members; as well as to improper or inadequate lubrication.

The design and location of vapor connections should be such as to provide against refluxed condensate running down the walls of the vessel instead of dropping freely into the liquid. Improvements frequently result through changing the location of critical parts to points outside the condensation zone, or by process changes which limit the region in which condensation is occurring, as for example by reduction in process temperature, jacketing the vessel, or similar operation readjustments.

Use of the same type of metals together where possible is recommended in order to avoid galvanic corrosion. In the cases where necessity demands that dissimilar metals and alloys be used together in corrosive environments there are certain definite rules to follow in order to assure success of the combination. When dissimilar materials are to be used together it is best to determine beforehand that both have adequate resistance to corrosion by the process liquors under normal conditions. Nickel, Monel and the other high-nickel alloys may normally be used together with safety, and with copper, bronze, brass and

other copper-base alloys. In combinations with plain and low-alloy steels and cast irons, and with aluminum, zinc, and other metals less noble than nickel opportunities for appreciable galvanic corrosion may exist, and the proposed metal combinations should be considered carefully before new installations or changes in existing equipment are made.

Combinations of the relatively noble nickel and high-nickel alloys with less noble materials, such as steel and cast iron, are usually satisfactory when the exposed area of more noble material is small in comparison with that of the less noble.

When it is impossible to avoid using galvanic couples suspected as being dangerous non-metallic insulation in the form of gaskets, sleeves, and washers are recommended. These insulating gaskets should be applied in a manner to provide complete electrical insulation between the materials forming the couple.

It is good practice whenever feasible to coat large surfaces of the more noble metal in a galvanic couple with an insulating paint so as to reduce the effective area of the cathode in the galvanic cell. The use of cathodic protection, either from applied current or by sacrificial corrosion of a less noble metal such as zinc, may serve to lessen galvanic corrosion which otherwise might occur. In some instances where galvanic corrosion is not a problem the application of a protective current may serve to prolong equipment life or reduce metallic contamination where such is an important factor.

"AN OUNCE OF PREVENTION"

Many means may be used for extending the life of equipment already in service. Periodic and careful cleaning of equipment is a most important factor in assuring greatest possible life. Be sure to use cleaning agent recommended for the surface material. In the case of wire mesh and other process equipment utilizing metal in small sections it is of the utmost importance that acid cleaning agents be thoroughly flushed and rinsed off after the desired cleaning has been accomplished. This is important because the presence of diluted acid in restricted areas, away from free flow of process liquors, might promote concentration cell corrosion. This same precaution is necessary in large vessels especially around seams and connections where the type of joint is likely to be such as to provide a crevice.

Other precautions that will lengthen the life of equipment should be mentioned. Be sure that the metal is recommended for use in the production and handling of the particular chemical or combination of chemicals. Inhibitors are widely used to prevent attack by hydrochloric acid and other chemicals, but several authorities contend that even greater use could be made of these interesting agents.

STAINLESS STEELS

The service life of stainless steel equipment can be lengthened by following certain precautions. Remove materials and deposits that tend to adhere to the surface, especially in crevices and corners. Cleanliness can not be stressed too strongly. Work for uniformity in regard to solutions, temperatures, agitation, concentration and surface conditions. Avoid prolonged standing of chlorides, bromides, thiocyanates and iodides in stainless steel equipment, especially if acid condition exists. The pitting action of these compounds may be retarded or avoided by making solutions alkaline. If this is not possible, avoid long contact of compounds with the metal and clean frequently. Be sure to avoid corrosion fatigue. This is usually the result of a combination of cyclic stresses and weld corrodents. The remedy is to make the equipment sufficiently strong to withstand any stresses which may be encountered. If this is not possible, the equipment or unit should be so constructed as to permit freedom of movement of the entire unit.

NICKEL

In the case of nickel and the family of high-nickel alloys, cleaning may be done with any of the alkaline cleaners. Dilute acid cleaners, such as sulphuric and hydrochloric, are also used extensively, and when so employed in correct strengths and at warm temperatures are not detrimental to the life of the materials. With some exceptions, nickel, Monel, and other nickel alloys which do not contain substantial amounts of chromium should never be cleaned with nitric or other oxidizing acids since these are corrosive to nickel and the other alloys mentioned, and will cause loss of metal through corrosion.

Scouring of nickel and nickel alloys is best accomplished with abrasive cleaners, such as finely divided pumice, or with those preparations compounded for household use. Steel wool or steel wire brushes should never be used on nickel and nickel alloy equipment since their use presupposes the likelihood that fine particles of steel will become embedded in the metallic surfaces with later development of rusting, and occasionally localized attack under the rust deposits. If brushes are to be used with the abrasive cleansers a stiff type of fiber brush is the best choice. Metallic wool scouring pads of nickel and Monel are commercially available and should be used where more severe scrubbing or scouring is indicated.

The use of organic inhibitors, of the types added to steel pickling acid solutions, with the cleaning acids employed on nickel alloy equipment is recommended.

The use of improper welding or brazing rods in making repairs on nickel and nickel alloy equipment frequently leads to trouble since the weld metal being of different composition from that of the parent metal may if less noble suffer accelerated galvanic corrosion. Fabrication and repairs are of course best made with rods of composition identical with that of the material being joined.

LEAD

Lead's resistance to corrosion depends in part on the extent to which its protective surface layer can be kept continuous and unbroken. By designing equipment in such a way as to restrict unnecessary movements of the metal or by exercising reasonable care to prevent mechanical injury to the protective coating lead will often last for a long time.

Regarding installation, the important point to remember is that lead requires adequate support at all

Life of stainless steel may be lengthened by removal of adhering materials

points where stresses may occur. Proper support not only reduces the possibility of mechanical failure but also restricts movements of the metal which, as pointed out above, are a contributing factor in corrosion.

Lead pipes in the horizontal position are usually supported by placing them in steel or wooden troughs. Vertical pipe lines may be held in position with steel straps, spaced 18 in. or so apart and securely bolted to a rigid supporting structure. Another method of supporting lead pipe, either vertically or horizontally, is by inserting and expanding it in standard steel pipe. Users of this procedure report that it is not only more satisfactory but cheaper than angle iron or wooden supports.

As in the handling and installation of lead, so in the treatment of lead equipment in service avoidance of physical injury and a proper regard for the metal's mechanical limitations are the guiding principles.

For example, when depositing or removing objects from a tank, care should be taken to avoid unnecessary contacts with the lining which might nick the lead or abrade its protective coating. Again, chemical solutions often deposit crystals, scales, crusts and the like, the removal of which is a common source of injury to linings. Workmen entering the tank should wear rubbers or other shoe coverings. Shovels, hoes, rakes and similar tools should be used with an appreciation of the necessity for careful handling to avoid trouble.

Where heating coils are employed, turning on of the steam should be done gradually through the use of needle valves. A sudden surge of pressure may distort the coils, rupturing the protective coating as well as weakening the metal structurally. The installation of thermostatic or pressure controllers which guard against excessive pressures and temperatures frequently prevents damage to coils through carelessness. The use of hot water instead of steam as the heating medium is another method of prolonging coil life, particularly where moderate temperatures are employed with chemicals such as chromic acid. While the former takes longer to raise the solution to the desired temperature, corrosion of the coil itself is retarded.

ALUMINUM

For most applications there is little or no reaction between aluminum and the substances being processed. In other cases, some reaction may occur. In cases of this type, it is often possible to extend the life of equipment appreciably by suitable protective measures (H. J. Fahrney and R. B. Mears, *Chem. & Met.*, Vol. 49, pp. 86-89, July, 1942).

Several protective measures which have proved beneficial are available. These methods include: (1) cathodic protection, (2) coatings, (3) chemical inhibitors, and (4) periodic cleaning.

Each of these methods has special fields of usefulness. Cathodic protection is particularly suitable for preventing attack by unrecirculated waters and by nearly neutral or slightly acid salt solutions. The liquids must have a relatively high conductivity and only areas of the metal exposed in contact with the liquid can be cathodically protected. In cases where it is applicable, cathodic protection is usually the cheapest and most effective method of preventing attack.

Chemical inhibitors are particularly useful in recirculated waters or in cases where the same material is to be stored for relatively long periods of time in the equipment under consideration. As with cathodic protection, only the metal areas below the liquid level are normally protected by inhibitors.

Protection against more severe conditions, such as the stronger acids, can best be obtained by coatings. These can be applied most readily to new equipment or to units which can be easily handled.

Periodic cleaning has proved most useful in cases where solid products settle out on the metal surface and adhere tenaciously to it. It is generally of little use where the liquids being processed uniformly dissolve the metal surfaces which they contact.

RUBBER

How to conserve rubber equipment was discussed in a recent article (O. S. True, *Chem. & Met.*, Vol. 49, pp. 88–89, Mar., 1942). In the planning which precedes the actual installation of rubber-lined equipment, the engineer should be careful to give the rubber manufacturer full and accurate information concerning service conditions. Specifications differ appreciably and the life of any installation may depend greatly on the completeness of the original information.

In the case of rubber-lined equipment, if it is necessary to enter, workmen should wear rubber-soled shoes to avoid abrading and cutting the lining. Care should be taken against the possibility of welding sparks or tools dropping into the tank from construction overhead. If there is a possibility of mechanical damage to the lining, it should be protected by wood bumper strips or brick linings set with acid-proof cement. Hard rubber-lined equipment should be protected against external shock—particularly in cold weather.

In the case of solid hard rubber material, operators should be instructed that the material is brittle and that normal methods of pipe handling should not be used. Pipe lengths should be fully supported, strap wrenches should be used for drawing threaded ends together, and temperatures and pressures should be within a range suggested by the manufacturer. Such pipe should be kept away from points where there is an excess of traffic and especially away from hand trucks, etc.

CARBON AND GRAPHITE

Carbon and graphite piping must be handled with a minimum use of high-pressure tools. It is recommended that pipe be handled and tightened by hand or with assistance of a rope wrench.

It is a good idea to carry in stock repair couplings and slab material. If a break does occur the broken pieces can be collected, fitted into original position and cemented together using carbonaceous cements recommended for the particular purpose by the carbon manufacturers. Should the broken pieces be too small to justify this type of repair it can be made by using the slab stock in store. Carbon slabs can easily be shaped to proper dimensions and cemented over the opening in the vessel.

GLASS LININGS

Glass-lined equipment that receives reasonable care is long-lived. There are many installations in good working order that have had continued use for over 20 years. The manufacturers report that if the following instructions are followed the life of linings can be lengthened materially:

1. When ready to clean, cool the equipment by flooding the jacket with cold water, then rinse the inside with cold water to remove deposits from the surface.

2. Scrub the glass lined surface with detergent solution. Use a commercial detergent which contains only a fine abrasive and soap. Take one part detergent and two or three parts water, mix and boil. (When boiling with direct steam in solution, use only two parts water.) Permit solution to cool, stirring occasionally to keep abrasive powder in suspension. Solution will form jellylike mass with abrasive evenly suspended.

3. Dip wet brush into detergent solution and scrub equipment. Do not put detergent solution in the vat.
4. After equipment has been scrubbed thoroughly, rinse with cold water.
5. Then rinse with hot water.
6. Sterilize according to normal procedure, either by heating through the jacket or directly with a steam hose. In case of the latter procedure, keep the end of the hose at least 12 in. from the glass-lined surface. Do not use hose with metal nozzle or metal weight on end of hose.

FUSED SILICA AND STONEWARE

Vitreous silica industrial equipment gives little trouble, but there are a few precautions that if followed will add length to its life. Avoid use of rigid joints between fused silica and other materials, all of which have higher thermal expansion, if the joint is to be subjected to high temperatures. It is advisable to avoid the use of hard setting cement on fused silica equipment at high temperatures for the same reason.

This equipment is suitable for operating temperatures up to 1,000-1,100 deg. C. in the absence of certain mineral salts or reducing gases which may accelerate breakdown due to denitrification. Temperatures as high as 1,350 deg. C. are possible if critical temperature zones between 1,250 deg. C. and 1,300 deg. C. and below 300 deg. C. are avoided.

Failure of chemical stoneware equipment may usually be traced to the use of the wrong body or to faulty installation. Stoneware bodies differ in their physical properties as widely as do different grades of steel and must be selected with equal care with particular reference to the service expected of them. The equipment should be installed so as to allow for expansion and contraction, to minimize vibration and tensile stress, and to take full advantage of the extremely high compressive strength that is characteristic of the ware.

SYNTHETIC RESIN

Tanks or other pieces of phenolic resin equipment, damaged in transit or by accidents in operation in such a manner as to produce holes or breaks may be refilled with some of the same type of resin and made as good as new without excessive cost. Minor repairs can be made on the premises by the user's own men and the equipment can be placed in service again after only a few hours. Surface damage need cause no concern as the material possesses uniform chemical resistance throughout.

The foregoing attempts to suggest a few of the ways by which the extremely limited stocks of strategic metals and alloys may be made to go farther and means for protecting what equipment we already have in an effort to make it last through the emergency. Every success that is thus achieved helps in winning the final Victory.

Alternate Materials

Most construction materials problems met in the design of equipment and buildings for chemical process industries are capable of a number of different solutions, and in normal times the engineer's task is to discover those materials which come closest to the ideal. These, however, are not normal times. Metals in particular, as well as rubber and plastics, are becoming increasingly difficult to secure, partly on account of actual shortages, and partly because of excessive inventory stocking on the part of some manufacturers. Certain of the scarcest materials are already subject to complete allocation, and others are sure to be added to the list. At present allocated materials can be had only for the most essential purposes and when nothing else, in the opinion of the authorities, can be substituted. But if current War Production Board moves are carried through, it is probable that such materials will not be available at all for production equipment, but only for the manufacture of offensive weapons.

To an ever larger extent, therefore, chemical engineers are finding it necessary to use materials which are inherently more plentiful, or in less demand, than the ones they may have been accustomed to use. Sometimes new materials can be found which will perform as satisfactorily as the old materials, or even better. In other cases, new uses are possible for old materials, or new ways of using them can be discovered. In general, however, the question of alternates comes down very largely to the application of well-known materials, which for reasons of personal preference, higher costs, or certain not-so-satisfactory properties, were ruled out before the preferred materials became unavailable. It is in the last group of possibilities that the great preponderance of solutions will be found.

Unfortunately, many of the construction materials that are being advanced as alternates are themselves hard to get today, owing to difficulties in transportation, or lack of sufficient production capacity to meet the present inflated demand. With many, the demand is now so large that reasonably rapid delivery can be made only to holders of relatively high priority ratings. Still, this statement is true only in a number of cases, and does not apply to all materials, nor to all equipment manufacturers. Each case must be checked individually. Furthermore, the supply situation is in a constant state of flux, and generalizations which are correct at one time may be untrue a week or a month later. An example is the case of lead, which a few months ago was one of the scarce metals. At present, lead is listed in the War Production Board's Materials Group III, which includes materials available for substitution.

Capacity to produce, rather than the availability of raw materials, is the limiting factor with most alternate materials. As a general rule, the best prospects for adequate supply are found with those materials which require the least manufacture, and make use of the least metal. Wood, cement and clay products are in this category, although even these may be scarce in some localities, while certain types such as structural lumber and refractory brick may be difficult to obtain anywhere.

Conversely, manufacturing bottlenecks in the case of other materials which ordinarily are easy to obtain have become fairly pronounced at present, and may become even more severe. Chemical stoneware, especially the more highly fabricated forms, requires materially increased delivery time. The same is true of structural carbon and of industrial glassware. Several of the plastics which would ordinarily be considered as available for alternate use are even harder to get than metals, including phenol-formaldehyde, acrylic and methacrylate, and vinyl chloride plastics, as well as synthetic rubbers and rubber reaction products. With the exception of natural rubber, all of these materials are of domestic origin, but competition with other war products for necessary raw materials and intermediates, and competition for the finished plastics, has made them unavailable for all but exceptional uses.

The higher alloy steels together with copper, nickel, aluminum, magnesium and their alloys can, of course, be obtained only on allocations. To save alloying elements in those steels which emphasize mechanical and physical properties, rather than temperature or corrosion resistance, several new series of lean alloy steels, known as the NE (National Emergency) steels have been developed by the steel industry and accepted by the War Production Board, and such steels must now be specified by metal fabricators for all uses where the need for higher alloys cannot be definitely established. Even these steels, however, can be obtained only with WPB permission, for the supply must be conserved for essential uses.

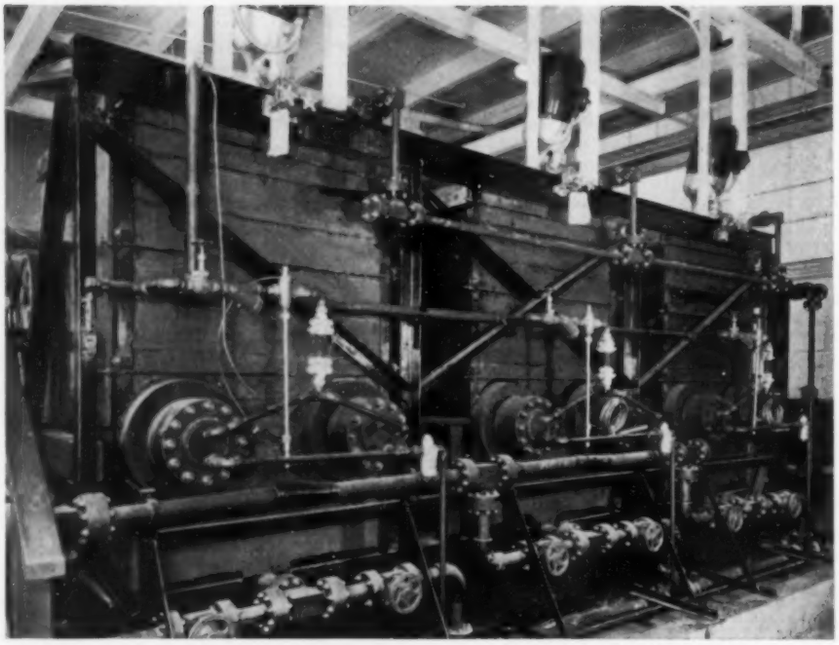
In the process industries, obviously, many construction materials are selected for their corrosion or heat resistance, rather than for mechanical properties, and so with alloys it is generally impossible to achieve the necessary resistance and still scale down the alloy content to any considerable extent. This situation is in part recognized in WPB Order M-21-g, which sets the maximum alloy content for a variety of heat-resisting applications.

The situation regarding cast iron seems to vary considerably. Some foundries appear to have plenty of material and are able to give rapid service, whereas others are demanding and getting high priorities for the work they perform. In any event, together with other metal fabricators, the foundries which consume more than $5,000 worth of metal per quarter must now submit their detailed quarterly requirements for government approval under the Production Requirements Plan. Presumably, as this plan becomes more effective through application of the experience now being gained with it, cast iron may become somewhat less freely obtainable.

METALS FOR METALS

Although most metals used for corrosion resistance, for alloying and for plating are on the critical list, there are several metals which can still be secured for use as substitutes. Also, of course, there is always the possibility of conserving the scarcer metals by using them as 10 or 20 percent plymetals. One interesting substitution that has recently been proposed to replace tantalum is to use platinum plated on copper or brass tubes for applications in contact with hydrochloric acid where good heat transfer must be secured. Gold is available for such applications and may be employed either as a plated coating or in the form of a plymetal. Silver, originally believed to be adequate in quantity for substitution, is now almost entirely under allocation.

As has already been noted, lead is now quite plentiful, which applies also to certain of its alloys used for equipment construction purposes, such as tellurium and antimonial lead. Another available material is a new high strength lead alloy, designed particularly for water-service piping.



These three boiling tanks are built of Karbate structural carbon which is used for wall slabs, heater tubes and heads and the pipes, valves and fittings

NON-METALLIC ALTERNATES

Carbon—Applications of structural carbon have developed rapidly in recent years. Ample raw material is available despite the enormous demand for carbon electrodes. The present chief deterrent to more widespread use of structural products lies in facilities for producing finished materials. Carbon can be obtained in both ordinary and impervious forms, as well as in a porous variety for filtration and bubble-producing applications. It is being fabricated in a wide variety of standard brick and block shapes, the latter so large as materially to reduce construction time of large equipment. Carbon tubes are being used extensively for their high heat transfer ability in the assembly of heat exchangers. All-carbon centrifugal pumps are being made, together with small vessels, cylindrical tower sections, valve bodies, fittings and pipes and a variety of other fabricated forms.

Concrete—Many ways have been developed for the use of concrete in tanks and vessels for liquids. Many proprietary compounds have been introduced for waterproofing concrete and for making it proof against other substances. Although some of these were based on rubber, many now obtainable with greater or lesser difficulty are plastic-base materials. For example, a new coating for concrete, wood or metal is made from a furfural type plastic said to be obtainable in quantities limited only by present production equipment. Films of this coating, built up by a number of brush applications, are thick enough for use in contact with all solvents, mineral and oxidizing acids in moderate concentration, vegetable and mineral oils and high octane fuels, according to the manufacturer. This coating, known as Tygon F, is intended for use up to 350 deg. F.

For other applications of concrete tanks, linings of chemical stoneware and porcelainware, or of structural carbon, may be used where the service is too severe for coatings. Most of the cements required for laying up these linings can be secured without difficulty, as well as the bituminous-base types of sheet lining material which are sometimes employed as a cushion and liquid proofing between the tile and the concrete wall.

Owing to metal shortages, cement-asbestos pipe has come into great demand, particularly for the handling of water and mildly corrosive solutions, as well as for fume ducts and

stacks. For more severe duty, cement-asbestos pipe is now being produced with resin-base coatings designed for a variety of degrees of service severity. Several manufacturers supply cement-asbestos pipe, together with a variety of fittings and couplings for working pressures up to 150 lb. per sq.in. or even higher.

Chemical Stoneware — Chemical stoneware, one of the old standbys of the chemical industry, and its newer cousin, chemical porcelainware, are produced in all of the forms in which structural carbon is available, as well as some additional forms which are possible because of the better working properties of clays as compared with carbon during the forming stage. For example, large single-piece storage vessels are built in sizes to several hundred gallons. Chemical stoneware is resistant to all corrosive agents with the exception of hydrofluoric acid, and in some modifications has good resistance to heat-shock. Recently developed types are much superior to the earlier grades in heat transfer and, with proper installation and use, modern materials of these types are not unduly fragile.

Enamel—Enamels, particularly the highly acid-resisting glass enamels which are proof against all acids except hydrofluoric (and sometimes phosphoric), are time-tried materials for producing an acid resisting coating on the more readily available base metals, including cast iron and low-carbon steel. A wide variety of processing equipment can be produced in glass-enameled metal, including kettles in all sizes up to 2,000 gal., or even larger; valves, pipes and fittings; storage tanks; stills and columns; pans and evaporators; and heat exchangers. Vessels are regularly built for internal pressures as high as 300 lb. per sq. in., while experimental autoclaves have proved successful under internal pressures as high as 1,000 lb., with temperatures to 600 deg. F.

Glass—Glass is an excellent example of an old material for which new forms and many new uses have recently been found through aggressive research on the part of several leading manufacturers. An example is the 96 percent silica glass which comes close to fused quartz in its resistance to thermal shock.

Industrial glass pipe has now become widespread, such pipe being made at present in diameters up to 4 in. An electric welding process for field erection of pipe, now in process of development, will doubtless extend this application much farther. The same type of chemically resistant, low-expansion glass has been employed in the manufacture of a standard design of all-glass centrifugal pump, in the fabrication of distilling column sections in diameters up to 23 in., in valves, in precision-bore tubing for flowmeters, in cooling coils and heat exchangers, and in other forms.

Glass blocks, in recent years, have become important adjuncts to building construction, owing to the fact that they are capable of transmitting light while at the same time they give considerable heat insulation and are capable of carrying a moderate load. An important advantage at present is that windows constructed from such units require metal only if movable sashes are to be installed.

FIBROUS GLASS

Fibrous glass is another important way in which this versatile material is making a conspicious contribution to the war effort. Fibrous glass can be woven into acid- and high-temperature-resistant filter cloths for liquid and gas filtration. It is being used to a large extent in the manufacture of electrical tapes and wire insulations. It is available for heat insulation in loose, pelleted, blanket, batt, and also in rigid forms. The last, one of the new products intended particularly for cold insulation, is impregnated for moisture proofness.

Perhaps the newest form of glass is the cellular product recently introduced for insulation, particularly in the low-temperature field, and for corrosion resisting floats of various kinds. This product is a foamy form of glass, the bubbles of which are non-communicating, yielding a material which is totally impervious to moisture absorption. Weighing about 10-11 lb. per cu.ft., the new glass has a heat transmission coefficient of 0.45 B.t.u. per sq.ft., deg. F., hour and inch of thickness and has sufficient strength to impart considerable structural rigidity and load-carrying capacity.

One novel use for glass has recently been suggested and appears to have possibilities as a war-time substitute for large metal pipe intended for operation at high pressures. The scheme is to blow or otherwise form pipe of suitable diameter and incase it in concrete to give adequate strength for such applications as over-land pipelines. Another suggestion for the same use is to substitute terra cotta pipe for glass, likewise incasing the terra cotta in concrete for strength.

Paints and Coatings—Chlorinated rubber is under allocation and hence is not regularly available for chemically resistant finishes. Resin coatings, such as the phenolics, are also scarce but are obtainable on priority ratings and can frequently be used in place of galvanizing or for the imparting of corrosion resistance to equipment constructed of the more plentiful materials. Some drying oils, resins and pigments are critical but adequate substitutes are available for use by the paint industry in the manufacture of most ordinary protection materials.

Plastics—The range of plastics now produced is extremely broad, but it is significant that several of these are required directly by the war program. For example, acrylic and methacrylate resins, recently used to a considerable extent in pump ends and step valves for proportioning pumps and in a variety of small equipment where visibility of the contents was necessary, are now going largely into airplane cockpit covers and bomber windows. Listed by the WPB in Group I (the scarcest materials) are the phenol-formaldehyde, polystyrene and polyvinyl chloride plastics, and in Group II (the somewhat less scarce materials), the urea-formaldehyde, vinyl, and vinylidine chloride plastics. Nevertheless, when they can be secured on sufficiently high priority, some of the polyvinyl, vinyl and vinylidine derivatives are being offered in interesting forms for substitution for metal pipes. Three such types include Saran, a vinylidine chloride derivative, Tygon, a vinyl chloride product, and Resistoflex, a polyvinyl alcohol derivative.

Saran is now being made in pipe sizes to 2 in. The material can be cut and threaded, coupled with compression-type couplings, or welded by heating the adjacent ends to the fusing temperature and then pressing them together. Saran is now being mentioned prominently as a possible substitute for brass and copper pipe in general piping applications. The material is suitable for temperatures up to about 175 deg. F. and is said to be satisfactory for contact with brines, hydrocarbons, solvents, organic compounds, acids and alcohols, except cyclic oxygen compounds and concentrated alkalis. Tygon is said to be more resistant to oxygen-containing compounds and strong alkalis, but is unsatisfactory with solvents such as benzol and chlorinated hydrocarbons. This material also is applicable at temperatures up to about 175 deg. F. Resistoflex, which is suitable

for temperatures to 285 deg. F., resists oils and solvents, but is not recommended for weak brines, acids and alkalis.

Silica—Fused silica, another of the old standbys of the chemical industry for use where great resistance to thermal shock and to all acids except hydrofluoric is required, is still available in adequate quantities, in spite of the fact that much of it is imported from England. The material is also fabricated in the United States.

Sulphur—Sulphur can be produced to meet any likely demand. In recent years various combinations of sulphur with inert materials and with a variety of hydrocarbons have been offered for use as acid-resisting cements for the setting of chemical stoneware units. Such materials continue to be available. Furthermore, some of these sulphur compositions are now under investigation for a variety of metal-replacing uses as yet unannounced.

Synthetic Rubbers—With the extreme shortage of natural rubber, a variety of applications for which no material but another rubber-like substance can substitute will necessarily fall in the province of the several synthetic rubbers. These at present can be obtained only in small quantities, but later will be produced on a large tonnage basis. The principal types to be manufactured will include the older synthetic rubbers, neoprene and Thiokol, together with Buna S, Buna N, and Butyl rubber. In general, these materials are characterized by a higher degree of resistance to solvents and other hydrocarbons than natural rubber. Generally, their temperature and aging resistance are better, their abrasion resistance relatively poor. However, the art of compounding synthetic rubbers for purposes similar to the principal uses of natural rubber is now developing rapidly in the United States, and present limitations on their applications will doubtless be overcome. Such necessary products as essential synthetic rubber linings, hose, tubing and gaskets will continue to be available. For example, neoprene coatings and linings, suitable for temperatures up to 220 deg. F., can be applied to metal equipment for resistance to strong oxidizing agents, aromatic and chlorinated hydrocarbons, and many other organics including certain ketones, esters, and phenols. Since such coatings can now be applied by brushing on a neoprene solution, they can effect an important saving of material amounting to two-thirds or three-quarters as compared with sheet linings.

Other plastics and synthetic rubber-like materials are also made for similar purposes. For example, Tygon, a name covering several different classes of coating and lining materials, is produced in one form for the sheet lining of various types of equipment, and in another form for brushing on. Tygon gaskets are being manufactured, as are gaskets made of Resistoflex.

Wood—Although in recent months construction sizes of lumber have been difficult to secure in many localities, the situation has varied so much from place to place that no general statement about availability can be made. Adequate material for wood tanks seems to be in the hands of most tank manufacturers and builders of cooling towers. When construction lumber is not to be had in one type or size, other types can often be adapted through changes in design or through the use of modern lumber connectors, which permit the fabrication of many forms of built-up trusses and beams.

Wood is also being employed in a variety of fabricated forms. For example, one oil company has announced the development of a plywood drum for the marketing of greases which will save some 2,000 tons of steel per year. The inner surface is chemically treated to prevent grease from penetrating the pores of the wood. Sheet plywood can be employed for many constructional purposes, but is hard to get in many localities, especially those waterproof types having a restricted binder. A high strength, super-compressed plywood for special strength-requiring applications is understood to be in process of development.

Wood, one of the oldest of all construction materials, has many desirable properties from an engineering standpoint. With the exercise of ingenuity, it can be adapted to many chemical industry uses as a substitute for metals. Wood tanks, without linings, are resistant to relatively severe attack from many chemicals. Linings of lead, sheet plastics, brushed-on plastics and ceramic materials can easily be applied. Even such applications as the construction of distilling columns (*Chem. & Met.*, May, 1942, p. 129) are possible with this versatile material.

Materials of Tomorrow

BACK IN THE FOOLISH DAYS OF 1929 a group of research metallurgists met in a smoke-filled room at the Book-Cadillac in Detroit to solve the future problems of one of our great industries. Before their surreptitious supply of synthetic stimulants had been exhausted, they had evolved complete specifications for a new alloy they christened *"automobilium."* We have since forgotten most of its properties, but still recall that it was to be as light as aluminum, as malleable as lead, as hard as a diamond, more machinable than butter, and as cheap as dirt—or thereabouts. Needless to say, this alloy, to solve all alloy problems of the automobile industry, somehow got lost in the depression.

But the story now has a modern and more successful sequel. On a hot Wednesday afternoon last July, a WPB executive telephoned the office of the American Iron & Steel Institute in New York. "We're holding a meeting here in Washington a week from Saturday to establish new steel specifications for . . .," and here the WPB man named certain important war products. "We'd like to have your alloy steel committee get busy and present at that meeting a series of new alloy steels which (1) can be made entirely from scrap with almost no addition of virgin alloying elements, and (2) can be used in place of the steels now doing the job without any change in design of the parts. Can it be done?"

The answer is that the seemingly impossible was accomplished. Working their laboratory staffs night and day for ten days, the top-flight metallurgists of five prominent alloy steel producing companies licked the problem and presented their report on schedule in Washington. Today the new steels, officially approved for war use, are in commercial production. They are expected to do their job fully as well as the steels they replaced, and in some respects even better.

Steel men may be justifiably proud of records such as these. Since 1939 they have practically trebled alloy steel production—from three to over eight million tons last year. And the curve is still going up!

All this resourcefulness on the part

of the metallurgical producers has its significance to chemical engineers who are looking ahead to the post-war period. Already we can visualize many new and superior steels tailored to fit the severest requirements of chemical processes. This war will leave us with a vast fund of metallurgical knowledge and experience on which we can build the chemical industries of the future.

MAGAL AGE APPROACHES

Steel's dominant position as a material of construction is not likely to be challenged immediately, but a new competition with other metals and alloys, plastics and glass, is certainly in the offing. Dr. William J. Hale, who became famous when he coined that useful word "chemurgy," predicted back in 1933 that we would shortly pass from the "Iron Age" to the "Magal Age"—when magnesium and aluminum and their alloys would best characterize our industrial progress.

Something more than the bare outlines of this Magal Age are already visible. By the end of 1943 we will have produced over 2 billion pounds of aluminum—6.5 times the production in 1939. Our magnesium output is variously estimated at 50 to 100 times the pre-war peak. In other words, on a purely weight basis we will have more tons of magnesium than we formerly had of aluminum, and more tons of both metals than we had of copper and zinc together in 1940. When we consider the different specific gravities of these metals and their relative effectiveness ton for ton in meeting various uses, it becomes obvious that the light alloys will offer increasingly severe competition to their older rivals on a volume, rather than weight, basis.

Now that the war has brought the price of aluminum down from 20 to 15c. per lb., and magnesium from 37.5 to 22.5c., there is an entirely different cost basis on which these metals will compete, once they are released from war uses. Calculated on the basis of equalized volume, with steel at 2c. per lb., the relative price for the same unit of volume for magnesium is 5.1c., for aluminum 5.45c., for zinc, 7.3c., and for copper 13.1c. And we must remember that the long-time trend of Magal prices is in one direction only—downward.

What can these lighter metals do for the chemical process industries? We can only project into the post-war future some of the trends and developments of the immediate past. Here are some present accomplishments that point toward the future:

Synthetic rubber bag converts box car into tank car

These cells represent the rubber industry's latest effort to solve the fuel transportation problem. Here you see a worker inspecting a cell following installation in the first experimental box car

1. An important manufacturer of vacuum pumps makes certain eccentric cams from magnesium alloys. They weigh but 2 lb. 10 oz. as against 9 lb. 12 oz. if they were made of cast iron. These lighter cams greatly reduce vibration, give better performance and longer equipment life.

2. A high speed laboratory centrifuge formerly had heads made of bronze that weighed 51 lb. The same design made of Magal weighed only 21 lb., greatly reduced starting inertia and wear on thrust bearings. The new equipment was easier to handle and actually cost less to manufacture.

3. Railway Express Agency wanted portable conveyors of the gravity type that could be used to unload their trucks and express cars. They had to be of light-weight construction yet able to stand up under constant and hard usage. Again, one of the new light alloys solved the problem. The new conveyor in sections 10 ft. long and 18 in. wide with 30 ball bearing rollers weighs only 68 lb. One man can carry it under his arm.

Aluminum stream-lined trains give us something else to think about. We have barely begun to use the light alloys on the scale their properties warrant. A freight car weighs 45,000 lb. and carries a load of 30,000 lb. One of the same capacity can be built to weigh only 15,000 lb. and should some day reduce transportation costs considerably.

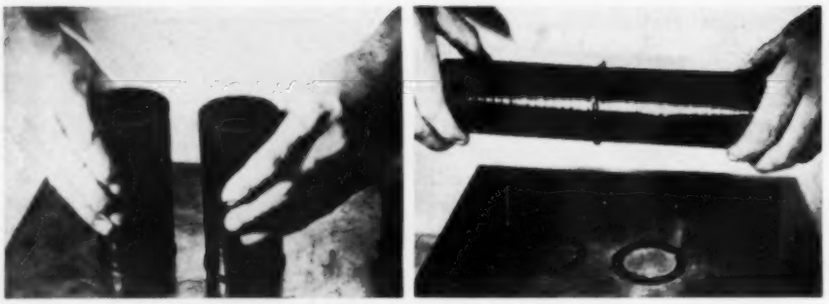
PLASTICS TO THE FORE

In defining the limits of the Magal Age, Dr. Hale reminds us that the same conditions, which are now ushering light alloys into wider industrial use, will eventually demand even greater strength with still further decrease in weight. It so happens there is no metal lighter than magnesium which is stable under atmospheric conditions. Hence the next step, in his opinion, must be outside of the domain of metals and into the organic chemical field. In fact, he predicts that by 1950 someone will have succeeded in incorporating partially oxidized silicon into the molecular structure of a new plastic that will thus combine the advantages of organic and inorganic compounds. Such "materials of tomorrow" he believes will exhibit tremendous strength, rigidity and resistance to weathering and oxidation. Most important, they should be cheaper and lighter in weight than any plastics now used as engineering materials.

In a metal-hungry economy such as ours today, plastics are finding many novel and valuable applications. A pump impeller made with a combination of a special phenolic plastic and an acid-resisting alloy has increased the efficiency of the pump in handling corrosive acids, at the same time reducing the weight of the impeller by 75 percent. This is typical of what is happening as designing engineers appreciate the fact that plastics are man-made materials and have greater versatility than most other structural materials. They can be literally "tailored" to fit almost any pattern of needs.

One of the most striking of such

applications is seen in the current announcement of a new plastic pipe. Made of Dow's vinylidine chloride plastic, it is highly resistant to moisture and most chemicals and solvents. Because it is thermoplastic, it can readily be heated and bent, and, of perhaps the most interest to plant engineers, it can be readily welded. For those who want to stick to the more orthodox procedures of the pipe fitter, the new plastic pipe can be threaded with ordinary iron pipe dies. Fittings, except for standard flanges, are not yet available, but threaded ells, tees and couplings are coming along soon. Thus vital metals and rubber are released for more urgent war needs and the chemical engineer has another new raw material with which to build his industries of the future.



New plastic pipe welded in less than a minute

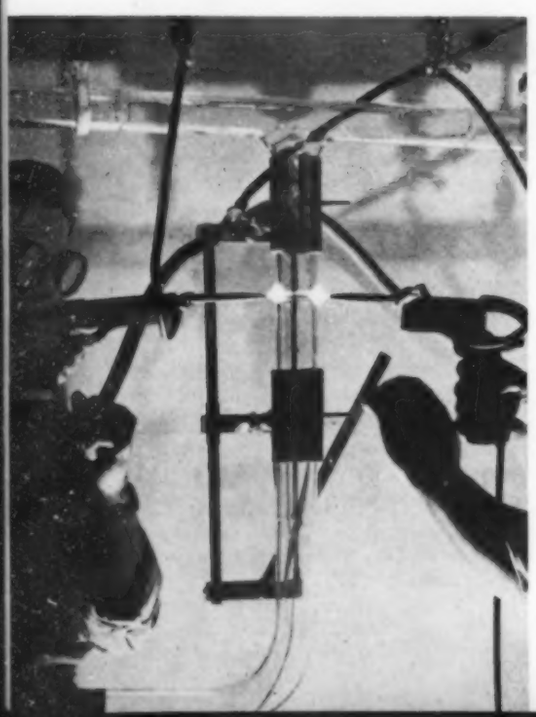
Pipe ends are first placed on a hot plate at 375 deg. F until melting begins, then firmly pressed together and allowed to cool for ten seconds. Resultant weld has greater joint strength than pipe itself

TONS OF SYNTHETIC RUBBER

Back in 1939 we celebrated the one hundredth anniversary of the vulcanization of rubber. Since then we have been made to realize all too poignantly that most of our little world rolls on this remarkable material. Now we are busy in a prodigious effort to make in the next two or three years almost twice as much rubber as we ever imported in a single year. Most of it we hope will be better—at least for certain purposes—than is the natural product.

Whether or not we shall ever return to the latter will depend on how good a job we do in our synthetic rubber plants, how greatly we can reduce the cost and improve the product. Assuming we are as successful as we hope we may be, our post-war economy is going to have another great new material resource.

Glass pipe can now be jointed on the job by electric welding using pin-point oxy-hydrogen flames to carry the high-frequency current



"THROUGH THE GLASS—DARKLY"

One of the lasting benefits likely to come out of our "ersatz" program in the United States is greater knowledge and valuable experience in using that most versatile of materials—glass. Fortunately, we did not have to start from scratch. In the past 15 or 20 years chemical engineers have installed literally miles of glass piping and have been building larger and more intricate equipment of this useful material. Centrifugal pumps that will deliver 100 g.p.m. of corrosive acid against a 65-ft. head are already here and pumps for higher pressures are coming. Tubular heat exchangers have been constructed with hundreds of 20 ft. lengths of thin-walled piping and fittings. Simple leak-proof methods of jointing are used on glass pipes up to 4 in. i.d. handling pressures up to 100 p.s.i. The next jump is going to be 6-in. pipes for use at slightly lower pressures.

Now comes the promise in the not very distant future of electric welding *on the job* as the equipment is being erected. Engineers with Corning Glass Works have been experimenting with portable equipment using oxy-hydrogen flames to act as conductors for a high-frequency current which will weld pipe ends together quickly and efficiently, thus eliminating all of the plant operator's headache associated with gasket troubles, leakage, corrosion and production contamination. Once this equipment is available and its operation is made fool-proof, nearly every plant will want to train its own "glass plumbers." Pipefitting may yet become a lost art!

Quartz is in many ways the ideal of the glassman who wants to serve industry. He worships it for its amazing strength and resistance to thermal shock, even though he knows how difficult it is to melt and shape to useful purpose. Recently, however, he has learned to put to industrial use the new 96 percent silica glass that comes awfully close to his prayer for quartz-like glass or glass-like quartz. Furthermore, the material is readily shaped and can easily be produced in intricate forms. With it he has been able to make things that could never before be accomplished—for example, thermocouple protector tubes that will stand up to 1,000 deg. C. in highly corrosive atmospheres, centrifugal pump seals that will run "dry" in almost red heat, and then withstand the thermal shock when cold liquid is again drawn into the pump.

Looking farther into the future the chemical engineer visualizes a greater place for glass as a material for the construction of reaction vessels, kettles and autoclaves. Trouble can not hide very long in transparent equipment, and there are obvious advantages in the visual control of many chemical reactions—particularly in the fine chemical and pharmaceutical fields. To prevent corrosion and resultant contamination of materials is the motive that will lead to ever-greater use of all-glass and glass-lined steel equipment.

* * * * * *

So, "through the glass darkly" we look ahead to the post-war period confident that there will be an ever increasing and more ingenious use of all the newer materials of construction. In a world gone mad with destruction there is consolation and encouragement to be gained from the fact that the war has brought us *constructive* achievements. They stand out as a challenge to the chemical engineer who is looking for new "materials of reconstruction" with which to build better and more efficiently in the future.

NON-METALLIC MATERIALS

CHEMICAL, STONEWARE, PORCELAIN, CEMENTS

Physical Properties of Chemical Stoneware and Porcelainware

Chemical Stoneware

The accompanying table, which has been prepared for us by the General Ceramics Co., gives the physical properties of an average grade of chemical stoneware. It should be emphasized here that "chemical stoneware" is not the name of a definite material, such as an alloy, but a generic term applied to a wide variety of ceramic compositions, and hence that in any particular composition designed to give optimum properties in one respect, it will ordinarily be impossible to secure optimum properties in all other respects.

Specific gravity	2.2	Modulus of elasticity, lb. per sq. in.	8,000,000
Hardness, scleroscope	100	Specific heat	0.2
Ultimate tensile strength, lb. per sq. in.	2,000-3,000	Thermal cond., B.t.u. per hr., sq. ft., °F., in.	10-35
Ultimate compressive strength, lb. per sq. in.	80,000	Linear thermal expansion, per °F.	0.0000020
Modulus of rupture, lb. per sq. in.	5,000-13,000	Water absorption, per cent	0-2

Chemical Porcelainware

Data supplied by Lapp Insulator Co.

Specific gravity	2.41
Ultimate tensile strength, lb. per sq. in.	5,-8,000
Ultimate compressive strength, lb. per sq. in.	100,000
Modulus of rupture, lb. per sq. in.	12,-15,000
Modulus of elasticity, lb. per sq. in.	10,400,000
Specific heat	0.2
Thermal cond., B.t.u. per hr., sq. ft., °F., in.	8.4
Linear thermal expansion, per °F.	0.0000023
Water absorption, per cent	0

Makers of Chemical Stoneware, Porcelain, Acidproof Brick and Stone

MANUFACTURER (Name and Address)	Materials
Chemical Stoneware	
General Ceramics Co., New York, N. Y.	Complete line, see note below
Maurice A. Knight, Akron, Ohio	Complete line, see note below
United States Stoneware Co., Akron, Ohio	Complete line, see note below
Chemical Porcelain	
Coors Porcelain Co., Golden, Colo.	Porcelain laboratory ware
Illinois Electric Porcelain Co., Macomb, Ill.	Chemical porcelain ware of all types
Lapp Insulator Co., LeRoy, N. Y.	Chemical porcelain ware of all types
Acidproof Brick and Other	
Acme Brick Co., FortWorth, Tex.	Acidproof brick
Alabama Clay Products Co., Birmingham, Ala.	Acidproof brick
Alberene Stone Corp. of Va., New York, N. Y.	Acidproof stone
Atlas Mineral Products Co., Mertztown, Pa.	Acidproof brick construction
Belden Brick Co., Canton, Ohio	Acidproof brick
Charlotte Chemical Labs., Charlotte, N. C.	Acidproof brick, rings
Clayecraft Co., Columbus, Ohio	Acidproof brick
Custodis Construction Co., New York, N. Y.	Acidproof brick construction, towers, tanks
Electro-Chemical Supply & Engineering Co., Paoli, Pa.	Acidproof brick and masonry materials
Filtros, Inc., East Rochester, N. Y.	Acidproof mineral as plates, cylinders, etc.
General Refractories Co., Philadelphia, Pa.	Acidproof tower packing, brick
Harbison-Walker Refractories Co., Pittsburgh, Pa.	Acidproof brick
B. Mifflin Hood Co., Daisy, Tenn.	Acidproof brick tower packings, flooring tiles
Ironton Fire Brick Co., Ironton, Ohio	Acidproof brick
Keagler Brick Co., Steubenville, Ohio	Acidproof brick
Kewaunee Mfg. Co., Kewaunee, Wis.	Karcite acidproof ceramic ware, and Kemrock chemical resistant stone
Laclede-Christy Clay Prod. Co., St. Louis, Mo.	Acidproof brick
McLain Fire Brick Co., Pittsburgh, Pa.	Acidproof brick
McLeod & Henry Co., Troy, N. Y.	Acidproof brick
Metropolitan Paving Brick Co., Canton, Ohio	Acidproof brick
National Carbon Co., Inc., Cleveland, Ohio	Carbon brick
Nukem Products Corp., Buffalo, N. Y.	Acid and alkali proof construction
Parker-Russell Mining & Mfg. Co., St. Louis, Mo.	Acidproof brick
Patterson Foundry & Machine Co., East Liverpool, Ohio	Acidproof lining blocks and grinding balls
Quigley Co., New York, N. Y.	Acidproof brick
Robinson Clay Product Co. of N. Y., New York, N. Y.	Acidproof and vitrified sewer tile
Southern Clay Mfg. Co., Chattanooga, Tenn.	Acidproof brick
Thornton Fire Brick Co., Clarksburg, W. Va.	Acidproof brick
Uhl Pottery Co., Huntingburg, Ind.	Acidproof ceramics

Note: Makers of complete lines of chemical stoneware supply such equipment as acid plants; ball mills; brick and tile; blowers and exhausters; coils; filters; acid-proof laboratory sinks, drain and vent lines; jars; jugs; kettles; pipe, fittings and valves; stills; tourills; towers, tower linings and tower packings; tanks and pumps; and many types of special equipment.

Makers of Cements and Putties for Acidproof Brick and Stoneware

MANUFACTURER (Name and Address)	Trade Names	Compositions, Applications, Types
Anti-Hydro Waterproofing Co., Newark, N. J.	Anti-Hydro	Water-, acid-, alkali-, oil-resisting concrete mix
Atlas Lumnite Cement Co., New York, N. Y.	Lumnite cement	Cement for corrosion and temp.-resistant concrete
Atlas Mineral Products Co., Mertztown, Pa.	Tegul-Vitrobond,-Mineralead, Tileset, Korez, G. K., others	Thiokol-sulphur-base, chemical-setting silicate and resin-base and other cements for all acid and alkali proof construction
Charlotte Chemical Labs., Charlotte, N. C.	Carolina Acid-Proof Cement. Acid-proof putty	Acid-proof cements and putty
Chemical Construction Corp., New York, N. Y.	Acipruf	Acidproof cement
Custodis Construction Co., Inc., New York, N. Y.	Custodis resin cement, Penchlor, Asplit	Synthetic resin, sodium silicate & phenolic base cements, resp.
Electro-Chemical Supply & Engineering Co., Paoli, Pa.	Duro Standard, Triple X, Syntho, Brimsto, Kemitite, Alk-Li-Pruf	Cements for all acid and alkali conditions; also water and steam
Filtros, Inc., East Rochester, N. Y.	Filtros	Acidproof cement
General Ceramics Co., New York, N. Y.	Acidproof Nos. 1, 6, 7, 8	Silicate cements and linseed oil- and asphalt-base putties
B. F. Goodrich Rubber Co., Akron, Ohio	Plastikon	Rubber-base putty
The Haveg Corp., Newark, Del.	Havegit 41, 43, 50	Self-hardening phenolic resin cements for acids and alkali
M. W. Kellogg Co., New York, N. Y.		Acidproof cement
Maurice A. Knight, Akron, Ohio	Knight	Silicate cements for strong acids

(Continued next page)

Makers of Cements and Putties *(Continued)*

MANUFACTURER (Name and Address)	Trade Names	Compositions, Applications, Types
Nukem Products Co., Buffalo, N. Y.	Basolit, Plasul, Basolit, Hydro-Plasul, Nukem Resinous Cements, Nu-Mastic, Nukem Primer, Nukem Enamel	Rubberized Sulphur Cements, acid and alkali resin base cements and others for complete acid-proof construction and protection
Paraffine Cos., San Francisco, Calif.		Acidproof cement
Patterson Foundry & Machine Co., East Liverpool, Ohio	Porox Cement	Silicate cement for strong acids
Pecora Paint Co., Philadelphia, Pa.	Acitite, Acichlor, Cushion Putty	Slow- and quick-drying cements and elastic putties for acids
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.	Penchlor acid-proof cement, Asplit, Causplit	Chemical-setting silicate cement for acids; self-hardening resin cements for acids and alkalis
Philadelphia Quartz Co., Philadelphia, Pa.	"S" Brand and N38 Special Sodium Silicates	Sodium silicates for regular and quick-setting acidproof cements
Quigley Co., New York, N. Y.	Acid-proof, black, gray, quick setting	Silicate cements for acid gases and mineral acids
Reardon Cement Co., Cincinnati, Ohio	Bedford	Acid and alkali resisting cements and plastics
The Sullivan Co., Memphis, Tenn.	Acidol, Sulsilo	Pouring cements and pre-mixed silicate cements for strong acids
Sauereisen Cements Co., Sharpsburg, Pa.	Insa-Lute Nos. 31, 48, 46, 44	Quick-setting, air-drying, sulphur and bitumastic cements
United States Stoneware Co., Akron, Ohio	Portite, Pre-Mixt, Calktite and others	Silicate cements of all types, resin cements, putties, etc.
Union Bay State Co., Cambridge, Mass.	N Series (neoprene base) cements, and special base cements	Neoprene and special base cements. For painting metals, rubber, wood, or concrete. Coating cloth. As adhesive

STRUCTURAL CARBON AND GRAPHITE

Representative Physical Properties of Porous Carbon and Porous Graphite

Grade Porous Carbon ("Carbocell") and Porous Graphite ("Graphicell")	Porosity Percent	Average Pore Diameter		Filter Action Min. Diameter Particle Retained Inches	Av. Water * Permeability at 5 Lb./sq.in. Pressure Gal./sq.ft./min.	Av. Air ** Permeability at 2 inches H_2O Pressure Cu.ft./sq.ft./min.
		Inches	Microns			
Grade C	36	0.0002	5	———	0.30	....
Grade 60	48	0.0013	33	0.00047	14.0	....
Grade 50	48	0.0019	48	0.00079	30.0	....
Grade 40	48	0.0027	69	0.00098	45.0	4.0
Grade 30	48	0.0039	99	0.00173	80.0	8.5
Grade 20	48	0.0055	140	0.00300	120.0	17.0
Grade 10	48	0.0075	190	0.00590	175.0	33.0

NOTE: "Carbocell" products can be treated so as to be wettable for use in caustic filtration. Both "Carbocell" and "Graphicell" products are resistant to most acids and alkalis.
* Water at 70 deg. F, 1 inch thick plate. ** Air at 70 deg. F and 760 mm. Hg pressure, 15 per cent relative humidity, 1 inch thick plate.

Representative Physical Characteristics of Carbon and Graphite Products

	Density		Strength, Lb. per Sq. In.			Elastic Modulus Lb./sq.in. Multiply by 10^5	Specific Resistance Ohms./In.^{3}	α (Thermal Expansion, See Note)	Thermal Conductivity B.t.u./hr./sq.ft./°F per ft.
	G./c.c.	Lb./cu.ft.	Tensile	Compressive	Transverse				
Carbon Cylinders									
8 inch dia.	1.54	96.1	660	2,920	1,320	5.5	0.0013	13	6.0
10–14 inch. dia. inc.	1.525	95.2	470	2,120	950	5.4	0.0013	12	6.0
17–24 inch. dia. inc.	1.54	96.1	400	2,200	790	5.4	0.0014	13	6.0
30–40 inch. dia. inc.	1.54	96.1	400	1,910	810	4.3	0.0026	12	6.0
Carbon Beams and Blocks									
4x4 inch to 6x6 inch inc.	1.57	98.0	840	4,100	1,670	9.4	0.0018	14	4.0
6x6 inch to 20x20 inch inc.	1.55	96.7	500	2,140	990	7.1	0.0016	15	4.0
15x30, 24x30 & 24 inch sq.	1.54	96.1	400	1,910	810	4.3	0.0026	12	4.0
Carbon Pipe and Tubes									
½–4 inch I. D. inc.	1.51	94.2	885	10,200	2,700	21.0	0.0014	15	3.0
5–10 inch I. D. inc.	1.49	93.0	980	8,140	2,550	17.0	0.0016	21	3.0
Carbon Brick									
Standard sizes	1.55	96.7	1,530	8,320	3,070	10.3	0.0016	13	3.0
Graphite Cylinders									
To 5–½ inch dia. inc.	1.56	97.3	760	3,050	1,750	8.8	0.00036	5–12	84.0
6–12 inch dia. inc.	1.55	96.7	610	3,420	1,810	8.0	0.00037	6–12	79.0
14 inch dia.	1.53	95.5	580	3,180	1,490	6.7	0.00039	8–12	70.0
16 & 18 inch dia.	1.53	95.5	500	3,180	1,490	6.7	0.00040	8–12	70.0
20 inch dia.	1.53	95.5	440	3,180	1,490	6.7	0.00040	8–12	70.0
Graphite Beams and Blocks									
To 5 inch thick inc.	1.56	97.3	700	3,050	1,750	8.8	0.00036	5–12	94.0
6 inch thick to 144 sq. in.	1.55	96.7	700	3,420	1,810	8.0	0.00037	6–12	84.0
Over 144 sq. in. section	1.53	95.5	570	3,180	1,490	6.7	0.00039	8–12	79.0
Graphite Pipe and Tubes									
½–4 inch I. D. inc.	1.68	104.8	780	4,550	2,820	14.0	0.0003	12	94.0
5–10 inch. I. D. inc.	1.67	104.2	870	5,100	2,980	13.0	0.0003	12	84.0

Structural Carbon and Graphite *(Continued)*

	Density		Strength, Lb. per Sq. In.			Elastic Modulus Lb./sq.in. Multiply by 10^{-5}	Specific Resistance Ohms./In.^{3}	α (Thermal Expansion, See Note)	Thermal Conductivity B.t.u./hr./sq.ft./°F per ft.
	G./c.c.	Lb./cu.ft.	Tensile	Compressive	Transverse				
Graphite Brick									
Standard sizes	1.56	97.3	700	3,050	1,750	8.8	0.00036	5-12	84.0
"Karbate" Pipes and Tubes, 10 Series*									
½-2 inch I. D. inc.	1.77	110.0	1,700	10,500	4,170	29.0	0.00164	27	3.0
Over 2 inch I. D.	1.76	110.0	2,000	10,500	4,640	26.0	0.0016	33	2.8
"Karbate" Pipe and Tubes, 20 Series*									
½-2 inch I. D. inc.	1.86	116.0	2,600	8,900	4,650	23.0	0.00034	23	85.0
Over 2 inch I. D.	1.91	119.0	2,350	10,500	4,980	21.0	0.00033	24	75.0
"Carbocell" (Porous Carbon)†									
Grade C (Finest)	1.34	83.6	500	2,700	1,530	>1.2	0.0020	6	3.0
Grade 60	1.05	65.5	190	850	600	>1.2	0.0070	27	1.5
Grade 50	1.05	65.5	180	830	500	>1.2	0.0070	27	1.4
Grade 40	1.04	64.9	120	900	320	>1.2	0.0057	27	1.0
Grade 30	1.04	64.9	100	770	250	>1.2	0.0070	27	1.0
Grade 20	1.03	64.3	90	700	240	>1.2	0.0070	27	1.0
Grade 10	1.03	64.3	80	300	160	>1.2	0.0080	27	1.0
"Graphicell" (Porous Graphite)†									
Grade C (Finest)	1.35	84.3	600	1,680	1,080	....	0.00045	6	60.0
Grade 60	1.05	65.5	110	500	250	....	0.0012	21	50.0
Grade 50	1.05	65.5	110	500	250	....	0.0012	21	45.0
Grade 40	1.04	64.9	100	500	190	....	0.0013	21	45.0
Grade 30	1.04	64.9	80	520	200	....	0.0017	21	40.0
Grade 20	1.03	64.3	60	310	140	....	0.0020	21	30.0
Grade 10	1.03	64.3	50	270	140	....	0.0020	22	20.0

Carbon and graphite products are resistant to most acids and alkalis. * For chemical resistance see table in Chem. & Met. Sept. 1940, p. 607. † See preceding table for additional data.
NOTE: Coefficient of Thermal Expansion per Degree: To Temperature t°F = [a+0.0039t (°F)] 10^{-7}; to Temperature t°C = [1.8 a+0.007t (°C)] 10^{-7}.

Makers of Structural Carbon and Graphite Products

MANUFACTURER (Name and Address)	Products	MANUFACTURER (Name and Address)	Products
Acheson Graphite Corp., New York, N. Y.	Graphite electrodes and various shapes	Speer Carbon Co., St. Mary's, Pa.	Carbon and graphite brick, plates, blocks, tubes, cylinders, bushings, shapes
International Graphite & Electrode Corp., St. Mary's, Pa.	Graphite electrodes and various shapes	Stackpole Carbon Co., St. Mary's, Pa.	Various carbon and graphite products
National Carbon Co., Inc., Cleveland, Ohio	Carbon and graphite brick, tile, tower packing, tubes, pipe, special shapes, electrodes	Note: Manufacturers of graphite crucibles are listed under "Refractories"	

SYNTHETIC RUBBER

Chemical Properties of Synthetic Rubber

EDITOR'S NOTE: The following paragraphs describing the chemical properties of some of the synthetics have been supplied to us by the manufacturers. They are intended to give an indication of the possibilities and the limitations of these materials. However, for a particular application it is generally advisable to contact the manufacturer and have specific tests made.

BUTYL RUBBER

Butyl rubber is a hydrocarbon polymer obtained by the copolymerization of an olefin and a diolefin. The chemical unsaturation is much less than that present in natural rubber and is usually between 1 and 5 percent of natural rubber. Butyl rubber undergoes thermal curing in the presence of sulphur and aided by many of the common rubber accelerators as well as by zinc oxide and fatty acids its tensile strength is greatly increased, its cold or hot flow properties surpressed, and its elongation reduced. After thermal curing butyl rubber compounds resemble natural rubber compounds in many of their mechanical properties. In the uncured state or "as received" butyl rubber is of a consistency equivalent to moderately well broken down natural rubber. It can be processed and generally handled much the same as natural rubber using the same type of equipment.

The general physical properties of vulcanized butyl rubber compounds can be compared with natural rubber as follows:

Elasticity and extensibility in the range of natural rubber—resilience lower than natural rubber at room temperatures but increases remarkably with increasing temperatures.

Abrasion resistance—equal to natural rubber for some services and slightly inferior for other services.

Compression set—somewhat higher than natural rubber.

Tear resistance—equal to natural rubber.

Flexibility at low temperatures—equal to natural rubber.

Butyl rubber is far superior to natural rubber for:

1. Resistance to water absorption.
2. Aging in storage and sunlight.
3. Resistance to the action of air and ozone.
4. Resistance to deterioration by heat.
5. Resistance to the action of nitrogen-containing solvents such as nitrobenzene and aniline.
6. Resistance to oxygenated solvents such as ethers, alcohols, and esters.
7. Resistance to swelling in vegetable and animal oils.
8. Resistance to many corrosive chemicals.
9. Extremely low gas permeability.

Exposure 2 Weeks At Room Temperature

		Effect
Hydrochloric acid	37%	Slight
Sulphuric acid	95.5%	None
Nitric acid	71.5%	Not serious
Phosphoric acid	85%	Slight
Ammonium hydroxide	25%	Slight
Sodium hydroxide	30%	None
Lactic acid	85%	None

Swelling in Vegetable and Animal Oils

5 mo. exposure in	*Natural Rubber*	*Perbunan*	*Butyl*
Linseed oil	124	17.2	10
Rapeseed oil	106	0.4	6
Soya bean oil	199	0.0	4
Lard oil	111	0.7	10
Olive oil	121	2.9	12
Oleic acid	196	35.0	108
Cotton seed oil	84	— .9	10

HYCAR

Hycar is available in two types, oil resistant (OR) and oil soluble (OS).

Either type can be compounded to give a wide range of physical properties, depending on the qualities desired. Hycar OR is extremely resistant to all petroleum products, vegetable oils, fats, paint and ink driers. It is quite resistant to benzol and carbon tetrachloride, but is badly swollen by acetone. It has a high resistance to water as compared to natural rubber and may be used where resistance to dilute acids and alkalis is important. Ordinary compounds of Hycar OR have excellent heat resistance and special compounds designed specifically for heat resistance are outstanding. It can be used at temperatures of 300 deg. F. and in a few limited applications can be considered for use up to 400 deg. F. Stiffening occurs at temperatures of —50 deg. F., but pliability is recovered immediately when temperature rises. Abrasion and age resistance are much superior to natural rubber. Ability to absorb energy is much better than natural rubber and flex life is comparable, making it excellent for vibration dampening service.

Hycar OS is equal to OR in resistance to heat, cold, sun, abrasion, aging, but gives somewhat lower tensiles. While not especially resistant to petroleum products, it is less affected by aliphatic hydrocarbons than natural rubber. It is superior to Hycar OR in elasticity and rebound and in general more nearly resembles natural rubber than other synthetics. Hycar OR and OS can be blended together to form many desirable compounds. Likewise they are compatible with poly vinyl chloride and many similar materials and usually in the blend the better properties of both are found.

NEOPRENE

Neoprene is a basic thermosetting raw material which is mixed with compounding ingredients and processed into finished products by rubber manufacturers. There are several different basic types of neoprene which have widely varying properties. Neoprene is available in black, white and colors, odorless when specified.

Animal, vegetable and petroleum-base products cause slight swelling but have little effect on the physical properties. Neoprene does not dissolve, become gummy or slough off.

In general, neoprene may be used in contact with inorganic chemicals. Salts have little effect. Even strong alkalis may be successfully handled. Mineral acids cause deterioration when used in concentrations above 50 per cent. Strong oxidizing acids, such as sulphuric, nitric and chromic, should be avoided. Halogens cause embrittlement in liquid form; however, dilute gas and aqueous solutions may be handled satisfactorily.

Neoprene resists the attack of most organic compounds, the more highly saturated compounds having less effect than the less saturated. Neoprene is not recommended for use with the chlorinated hydrocarbons or with creosote. Certain aromatic solvents such as benzol also cause rapid swelling.

The Union Bay State Co. has compounded and the G..tes Engineering Co. has developed a technique for applying Gaco-Neoprene linings to tanks by simply brushing it on in the form of solutions of highly concentrated surfacing compound over suitable primers. The primer will not soften below 260 deg. F. which prevents blistering and falling when the temperature accidentally rises a little too high. By this means tanks may be corrosion proofed on the job at relatively low cost. The neoprene lining thus applied may be allowed to vulcanize itself at room temperature or cured immediately by means of steam or hot water. The process only requires about ¼ to ¼ as much neoprene as is required by the sheet method of mining tanks. The linings are very satisfactory for resisting the following chemicals:

Chemical	*Conc.*	*Probable Safe Max. Temp.*
Chlorine water	Up to 3%	82F
Hydrochloric acid	Up to 20%	212
Hydrochloric acid	Over 20%	82
Phosphoric acid	Up to 85%	220
Sulphuric acid	Up to 50%	220
Aluminum chloride	Up to 25%	160
Ammonium nitrate	Up to 50%	220
Calcium chloride	Up to sat.	220
Ferric chloride	Up to 25%	200
Silver plating sol.	Standard	220
Sea water		220
Sodium chloride	Up to sat.	220
Sodium hydroxide	Up to 70%	220
Sodium sulphide	Any	200
Acetone		Boiling Pt.
Formaldehyde	Up to 40% aqueous sol.	82

PERBUNAN

Perbunan is a synthetic rubber-like material which can be processed and vulcanized with sulphur in much the same way as natural rubber. Like the latter, it can be compounded to give varying physical properties depending on the particular application in mind. With active carbon black it can be reinforced to give compounds of high tensile strength and superior abrasion resistance. In addition, it has high elasticity and resilient energy (low hysteresis loss), and has good resistance to prolonged stress (slight creep under prolonged loading). The heat conductivity is about 20 per cent higher than that of natural rubber.

Perbunan has excellent aging properties and possesses good heat and fatigue resistance. With proper compounding it can be used at temperatures up to 300 deg. F. and will remain flexible at temperatures as low as —45 deg. F. Perbunan compounds of the ebonite or hard rubber type can be used for much more severe temperature conditions than natural rubber ebonite compounds.

Perbunan is unaffected by water dilute acids or alkalis, or salt solutions of any concentration. It swells very slightly in aliphatic hydrocarbons, vegetable and animal oils and fats. The reduction in physical properties as a result of swelling is small, making Perbunan especially suitable for gasoline and oil-resistant applications. Crude Perbunan or uncured Perbunan compounds are soluble in aromatic hydrocarbons. However, cured compounds swell to a much lesser extent than cured natural rubber compounds. It is superior to natural rubber for mixtures

Physical Properties of Synthetic and Natural Rubber

Material	Specific Gravity	Tensile Strength, lb./sq. in.	Hardness, Shore Durometer	Max. Temp. for Use, °F.	Dielectric Strength, v./mm.	Effect of Heat	Abrasion Resistance	Effect of Sunlight	Effect of Aging	Machining Qualities
Buna S	0.94	3,800	15–90	300	.....	Stiffens	Equal to rubber	Slight	Equal to rubber	Can be ground
Butyl Rubber	0.91	500–3,000	15–90	250–300	25,000	Softens slightly	Good	None	Better than rubber	Can be ground
Chemigum, Oil Resistant	1.0–1.5	800–4,000	30–90	300	.....	Stiffens	Excellent	Equal to rubber	Stiffens	Can be ground
Chemigum, Tire	1.0–1.15	1,000–4,000	50–65	450	.....	Stiffens	Excellent	Deteriorates	None	.....
Hycar, OR or OS, hard	1.1–1.3	4,000–11,000	.....	300	.....	Softens at 300 F.	Good	Very slight	None	Excellent
Hycar, OR, soft	0.99–1.6	1,000–4,500	15–95	300	.....	Stiffens slightly	Excellent	Slight	Highly resistant	Can be ground
Hycar, OS, soft	0.96–1.20	1,000–4,000	20–95	280	....	Stiffens slightly	Excellent	Slight	Highly resistant	Can be ground
Koroseal, hard	1.3–1.4	2,000–9,000	80–100	212	30,000–50,000	Softens	Good	None	None	Good
Koroseal, soft	1.2–1.3	500–2,500	30–80	190	15,000–30,000	Softens	Good	None	None	Can be ground
Neoprene	1.25–1.30	1,000–4,500	10–95	300	.....	Stiffens slightly	Excellent	None	Highly resistant	Can be ground
Perbunan	0.98	500–5,000	30–90	300	.....	Stiffens	Excellent	Slight	Highly resistant	Can be ground
Pliolite, No. 40	1.06	4,000–5,000	.....	160–248	.....	Softens	.....	None	None	.....
Resistoflex	1.26	2,000–5,000	.....	250	6,000–10,000	Softens	Good	None	None	.....
Thiokol FA	1.34	1,400	25–90	200	.....	Hardens slightly	Fairly good	None	None	Excellent
Tygon T	1.33–1.36	9,000	.....	175	35,000–50,000	Softens	Good	None	.....	Excellent
Vistanex, Medium	0.9	200	.....	.....	.....	.....	.....	None	Better than rubber	Cannot be mach.
Vistanex, High	0.9	550	.....	.....	.....	.....	.....	None	Better than rubber	Cannot be mach.
Natural Rubber, hard	1.17–1.18	4,000–11,000	70–100	220	.....	Softens	Good	Discolors	None	Excellent
Natural Rubber, soft	0.93–1.17	1,000–6,000	30–80	150–180	.....	Softens and det.	Excellent	Deteriorates	Highly resistant	Can be ground

of gasoline with aromatic hydrocarbons. Chlorinated hydrocarbons and organic bases have a strong swelling action on Perbunan. Ketones, organic acids, alcohols and esters have a greater swelling effect than on natural rubber.

VISTANEX

Vistanex is the name of a series of polymers formed by the low-temperature polymerization of isobutylene. The chemical unsaturation of Vistanex is substantially nil, and consequently it is unattacked by the strongest chemicals, such as sulphuric acid, nitric acid and caustic soda. Hot concentrated nitric acid, however, after prolonged treatment, yields a yellow, sticky, oxidized product. Vistanex is also inert to ozone and is therefore useful in improving the ozone resistance of rubber compounds. Lacking in unsaturation, it therefore cannot be vulcanized and must be used in the raw gum state or with compounding agents to impart structural strength. It is soluble in all hydrocarbon solvents and oils and it may be precipitated from these solutions by the addition of low molecular weight alcohols, ethers or ketones.

Rubber compounds containing 50 per cent of Vistanex show no cracking with ozone within 10 to 20 min. while natural rubber shows considerable. A similar relation is observed in the action of sulphuric acid on rubber-Vistanex compounds. Vistanex is superior to natural rubber for resistance to water absorption, aging in storage, sunlight and all atmospheric conditions, resistance to ozone, resistance to strong chemicals, alkalies, salts and the usual oxidizing agents.

THIOKOL

The manufacturers of Thiokol synthetic rubbers state that a number of different organic polysulphide polymers that vary in characteristics from soft to hard rubber are made under this name. However, unlike natural rubber, the products are practically unaffected by petroleum hydrocarbons and most commercial solvents. They are resistant to alcohol, esters and ketones. The swell of these products in aromatic hydrocarbons varies from practically no swell to around 100 percent increase in volume, depending on the type. Even when Thiokol swells in aromatic solvents, it still retains good physical characteristics. It is not materially affected by carbon tetrachloride but is attacked by ethylene dichloride in varying degrees. Thiokol is not affected by sunlight, air, azone or ultra-violet.

It can be compounded to give various hardnesses and characteristics suitable for each particular application. While not possessing original tensile strength as great as natural rubber, it is stated for to exceed natural rubber in both strength and abrasion resistance when in contact with gasoline and oils.

TYGONS

The Tygons are synthetic materials, resembling rubber in many physical characteristics, yet entirely different in chemical structure. They consist of a series of modified halid polymers and diene derivatives compounded to various formulas to produce materials with a wide range of properties. Tygon may be compounded to be resistant to all inorganic acids (except fuming nitric), all inorganic salts, all organic acids (except glacial acetic), alkali solutions, and most of the hydrocarbons and solvents. It is unaffected by mineral oils, gasolines, fresh or salt waters.

Surface Affect of Immersion in Solutions for 7 Days at 25 Deg. C. for Tygon T.

30% Sulphuric acid	None
3% Sulphuric acid	"
10% Nitric acid	"
10% Hydrochloric acid	"
5% Acetic acid	"
10% Sodium hydroxide	"
10% Ammon. hydroxide	"
10% Sodium chloride	"
Distilled water	"
50% Ethyl alcohol	"
Acetone	Dissolved
Ethylene dichloride	"
Toluene	Soft, rubbery
Gasoline	None

Representative Makers of Industrial Rubber Products and Rubber-Like Materials

MANUFACTURER (Name and Address)	Products
American Hard Rubber Co., New York, N. Y.	Hard and soft rubber, neoprene and Thiokol linings, pipe, fittings, shapes, pails, pumps, rubber paint, anode process, etc.
Atlas Mineral Products Co. of Pa., Mertztown, Pa.	Rewbon seamless rubber linings, Neobon and Zerok synthetic resin linings
Boston Woven Hose & Rubber Co., Boston, Mass.	Conveyor and transmission belts, hose, mechanical rubber goods
Crane Packing Co., Chicago, Ill.	Rubber and synthetic rubber packings and seals
Custodis Construction Co., New York, N. Y.	Custoplast soft rubber and neoprene tank linings
Dayton Rubber Mfg. Co., Dayton, Ohio	Oilproof rubber belts, transmission belting, synthetic rubber products
E. I. du Pont de Nemours & Co., Neoprene Div., Wilmington, Del.	Neoprene polymerized chloroprene rubber
Firestone Tire & Rubber Co., Akron, Ohio.	Perbunan synthetic rubber
Garlock Packing Co., Palmyra, N. Y.	Rubber packings, transmission belting, molded goods
Gates Rubber Co., Denver, Colo.	V-belts, molded rubber goods, hose
L. H. Gilmer Co., Tacony, Philadelphia, Pa.	Transmission belting and special molded parts
B. F. Goodrich Co., Akron, Ohio	Acid- and abrasion-resistant linings, hose, conveyor and transmission belting, packings, hard-rubber pipe and molded goods, corrosion resisting paints, Koroseal, Anode process, Ameripol tires and mechanical goods
Goodyear Tire & Rubber Co., Akron, Ohio.	Hose, conveyor and transmission belting, packings, linings, Plioweld rubber lined tanks, pipe, etc., mechanical rubber goods, molded goods, Pliolite modified rubber plastic, Chemigum
Hewitt Rubber Corp., Buffalo, N. Y.	Hose, transmission and conveyor belting, packings
Hycar Chemical Co., Akron, Ohio	Synthetic rubbers (Hycar)
Jenkins Bros. Rubber Div., Bridgeport, Conn.	Mechanical rubber goods, rubber and synthetic rubber packings, valve discs, molded and extruded products, friction and insulated tape and tire valves
The Osborn Mfg. Co., Johns Conveyor Div., Cleveland, Ohio	Johns rubber and synthetic rubber "moving pipe-line" conveyors
Maurice A. Knight, Akron, Ohio	All-rubber acid shipping drums. Pyroflex resin-base tank linings
Linear Packing & Rubber Co., Philadelphia, Pa.	Rubber and synthetic rubber packings
Luzerne Rubber Co., Trenton, N. J.	Hard rubber pipe, fittings, valves, shapes tanks, rayon apparatus and other equipment
Manhattan Rubber Mfg. Div., Passaic, N. J.	Transmission and conveyor belting, blocks, hose, piping, rolls, brake lining, bearings
Miller Rubber Industrial Prod. Div., B. F. Goodrich Co., Akron, Ohio	Rubber and synthetic rubber hydraulic oil packings and seals
Paramount Rubber Co., Detroit, Mich.	Seamless rubber, neoprene and Paramount plastic linings, rubber paint, molds, coatings and insulations
Resistoflex Corp., Belleville, N. J.	Rubber-like oil-resisting resin — tubing, hose, sheets, molded shapes, gloves, aprons, solutions
Self-Vulcanizing Rubber Co., Chicago, Ill.	Liquid and plastic rubber self-vulcanizing coatings and lining materials
Standard Oil Development Co., Elizabeth, N.J.	Perbunan synthetic rubber
Jos. Stokes Rubber Co., Trenton, N. J.	Hard rubber and synthetic molded and extruded products
Thermoid Rubber Div., Thermoid Co., Trenton, N. J.	Transmission belting, multiple V-belts and drives, conveyor and elevator belting wrapped and molded hose, packings, industrial brake linings and friction products rubber covered rolls, pulley lagging
Thiokol Corp., Trenton, N. J.	Thiokol olefine polysulphide synthetic rubber — crude sheet, molding powder and liquid dispersions
U. S. Rubber Co., New York, N. Y.	Hose; conveyor, elevator and power transmission belting; packings; molded and extruded rubber; rubber bonded to metal; rubber linings (hard, semi-hard, soft for tanks, pipe, fittings, chutes and valves)
U. S. Stoneware Co., Akron, Ohio	Tygon synthetic resin products: tank linings, gaskets, tubing, acid-proof paints, cements, molded or extruded goods. Molded or extruded mechanical rubber goods, rubber linings
Union Bay State Co., Cambridge, Mass.	Gacco (neoprene base) compounds for tank surfacing and similar corrosion proofing purposes
Vulcanized Rubber Co., New York, N. Y.	Hard and semi-hard rubber molded products

PLASTICS AS ENGINEERING MATERIALS

Physical Properties of Principal Plastics Used as Engineering Materials

(From forthcoming book, "Plastics for Industrial Use", by John Sasso, McGraw-Hill Book Co., 1942)

Materials	Tensile Strength, (Lb. per sq. in.)	Compressive Strength, (Lb. per sq. in.)	Flexural Strength, (Lb. per sq. in.)	Impact Strength, Izod (Ft.-lb. per in. of notch, ½×½ in. bar)	Thermal Conductivity, 10^{-4} cal. sec./ sq. cm./ (deg. C./cm.)	Distortion Point, deg. F.	Thermal Expansion, (In. per in. per deg. C.) ($\times 10^{-6}$)	Dielectric Strength, (Short time, volts per mil, ⅛ in. Thickness, 1,000,000 cycles)	Water Absorption (Percent in 24 hours)
Phenolic:									
Wood-flour filled	4,000–11,000	16,000–36,000	8,000–15,000	0.15–0.25	4–12	240	5.5	300–500	0.2–0.6
Mineral-filled	4,000–10,000	18,000–35,000	8,000–20,000	0.13–0.72	8–20	290	3.2	250–400	0.01–0.3
Fabric-filled	5,000–8,000	20,000–32,000	8,000–13,000	0.8–4.8	.....	.....	4	150–450	0.5–2.5
Cast phenolic	5,000–12,000	10,000–30,000	9,000–14,000	0.3–0.4	3–5	.....	.....	300–450	0.01–0.5
Laminated Phenolic:									
Paper base	7,00018,000	20,000–40,000	13,000–20,000	0.6–7.6	5–8	.....	.....	400–1,000	0.3–9.0
Cotton base	8,000–12,000	30,000–44,000	13,000–30,000	1.4–15	5–8	.....	.....	150–600	.....
Asbestos base	7,000–12,000	18,000–45,000	10,000–35,000	1.8–11	7–9	.....	.....	100–150	.....
Phenol-furfural:									
Wood-flour filled	6,000–11,000	28,000–36,000	8,000–15,000	0.30–0.56	3–5	.....	3	400–600	.....
Mineral-filled	5,000–10,000	24,000–36,000	26,000–30,000	0.32–0.74	10–20	.....	2	200–500	.....
Fabric-filled	6,000–8,000	26,000–30,000	10,000–13,000	1.20–4.60	5–8	.....	5	200–500	.....
Urea-formaldehyde	5,000–13,000	24,000–35,000	10,000–15,000	0.28–0.32	7	260	3	650–720	1–3
Vinyl chloride	8,000–10,000	10,000–12,000	12,000–14,000	0.6–1.2	4	140	7	.....	.....
Vinylidene chloride	5,000–7,000	7,500–8,500	15,000–17,000	2.0–8.0	2.2	240	16	500	0.0
Me. methacrylate	4,000–7,000	10,000–15,000	10,000–15,000	0.2–0.4	4–8	160	8	500	0.4–0.5
Polystyrene	5,000–9,000	11,500–13,500	14,000–19,000	0.35–0.50	3–5	170	7	500–525	0.0
Ethyl cellulose	6,000–9,000	10,000–12,000	4,000–12,000	0.6–6.5	5–6	140	12	.....	0.5–1.5
Cel. acet. butyrate	2,500–7,500	7,500–22,000	2,800–13,000	0.8–5.5	5–8	150	13	.....	.....
Cellulose acetate	3,000–10,000	7,000–27,000	3,700–10,000	0.7–4.2	5–8	150	12	350–900	1.3–6.9

Types, Trade Names and Manufacturers of Principal Plastics*

Types	Trade Names	Manufacturers
Phenolic materials	Bakelite	Bakelite Corp., N. Y.
	Cardolite	Irvington Varnish & Ins. Co., Irvington, N. J.
	Celeron	Continental Diamond Fibre Co., Newark, Del.
	Coltrock	Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
	Durez	Durez Plastics & Chemicals, Inc., N. Tonawanda, N. Y.
	Durite	Durite Plastics, Philadelphia, Pa.
	Haveg	Haveg Corp., E. Newark, Del.
	Heresite	Heresite & Chemical Co., Manitowoc, Wis.
	Indur	Reilly Tar & Chemical Corp., Indianapolis, Ind.
	Insurok	Richardson Co., Melrose Park, Ill.
	Makalot	Makalot Corp., Boston, Mass.
	Resinox	Monsanto Chemical Co., E. Springfield, Mass.
	Temples	Bryant Electric Co., Bridgeport, Conn.
	Textolite	General Electric Co., Pittsfield, Mass.
Phenolic, cast	Bakelite	Bakelite Corp., N. Y.
	Catalin	Catalin Corp., N. Y.
	Gemstone	A. Knoedler Co., Lancaster, Pa.
	Marblette	Marblette's Corp., L. I. City, N. Y.
	Opalon	Monsanto Chemical Co., E. Springfield, Mass
	Prystal	Catalin Corp., N. Y.
Urea	Bakelite	Bakelite Corp., N. Y.
	Beetle	American Cyanamid Co., N. Y.
	Cibanoid	Ciba Corp., N. Y.
	Plaskon	Plaskon Co., Toledo, Ohio
	Uformite	Resinous Products & Chemicals Co., Phila., Pa.
Melamines	Melamac	American Cyanamid Co., N. Y.
	Melamine	Plaskon Co., Toledo, Ohio
Acrylics	Crystalite	Rohm & Haas, Phila., Pa.
	Lucite	E. I. duPont de Nemours Co., Arlington, N. J.
	Plexiglas	Rohm & Haas, Phila., Pa.
Vinyls	Alvar	Shawinigan Prod. Corp., N. Y.
	Butacite	E. I. duPont de Nemours Co., Wilmington, Del.
	Butvar	Shawinigan Prod. Corp., N. Y.
	Formvar	Shawinigan Prod. Corp., N. Y.
	Gelva	Shawinigan Prod. Corp., N. Y.
	Koroseal	B. F. Goodrich Co., Akron, Ohio
	Resistoflex	Resistoflex Corp., Belleville, N. J.
	Tygon	U. S. Stonewear Co., Akron, Ohio
	Vinylite	Carbide & Carbon Chemicals Corp., N. Y.
Vinylidene Chloride	Saran	Dow Chemical Co., Midland, Mich.
Polystyrene	Bakelite	Bakelite Corp., N. Y.
	Loalin	Catalin Corp., N. Y.
	Lustron	Monsanto Chemical Co., E. Springfield, Mass.
	Styron	Dow Chemical Co., Midland, Mich.
Cellulose Acetate	Bakelite	Bakelite Corp., N. Y.
	Cellulate	National Plastics Co., Detroit, Mich.
	Fibestos	Monsanto Chemical Co., E. Springfield, Mass.
	Gemloid	Gemloid Corp., N. Y.
	Lumarith	Celanese Celluloid Corp., N .Y.
	Macite	Manufacturers Chemical Corp., Jersey City, N. J.
	Nixonite	Nixon Nitration Works, Nixon, N. J.
	Plastacele	E. I. duPont de Nemours & Co., Arlington, N. J.
	Tenite I	Tennessee Eastman Corp., Kingsport, Tenn.
Cellulose Acetate Butyrate	Tenite II	Tennessee Eastman Corp., Kingsport, Tenn.
Ethyl Cellulose	Ethocel	Dow Chemical Co., Midland, Mich.
	Hercules	Hercules Powder Co., Wilmington, Del.
Laminated Materials	Aqualite	National Vulcanized Fibre Co., Wilmington, Del.
	Celianite	Continental Diamond Fibre Co., Newark, Del.
	Celeron	Continental Diamond Fibre Co., Newark, Del.
	Coffite	Formica Insulation Co., Cincinnati, Ohio
	Corresite	S. Blickman, Inc., Weehawken, N. J.
	Dilecto	Continental Diamond Fibre Co., Newark, Del.
	Dilectene	Continental Diamond Fibre Co., Newark, Del.
	Duraloy	Detroit Paper Products Co., Detroit, Mich.
	Formica	Formica Insulation Co., Cincinnati, Ohio
	Insurok	Richardson Co., Melrose Park, Ill.
	Lamicoid	Mica Insulation Co., N. Y.
	Lamitex	Franklin Fibre-Lamitex Corp., Wilmington, Del.
	Micarta	Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
	Panelyte	Panelyte Corp., N. Y.
	Ohmoid	Wilmington Fibre Specialty Co., Wilmington, Del.
	Phenolite	National Vulcanized Fibre Co., Wilmington, Del
	Spauldite	Spaulding Fibre Co., Tonawanda, N. Y.
	Synthane	Synthane Corp., Oaks, Pa.
	Taylor	Taylor Fibre Co., Norristown, Pa.
	Textolite	General Electric Co., Pittsfield, Mass.
	Ucinite	Ucinite Co., Newtonville, Mass.
	Vulcoid	Continental Diamond Fibre Co., Newark, Del.

* In this table only the more usual engineering plastics materials are listed by trade name and manufacturers. No attempt has been made to include all types of plastics materials, as that is beyond the scope of this issue of *Chem. & Met.*, which is concerned primarily with materials of construction for chemical engineering equipment. The engineer may find listings of molders and extruders as well as other valuable data in the forthcoming book by John Sasso, "Plastics for Industrial Use," McGraw-Hill Co., (1942), from which this list was largely compiled.

Determining the Most Suitable Plastics for use as Engineering Materials

The "Plastics Comparator" has been prepared by the Bakelite Corporation to serve as a guide in selecting the plastic or plastics to consider for industrial use. it rates the materials numerically without any attempt to indicate relative differences. Thus, the number (1) indicates the most suitable, and the larger numbers the order of suitability. The difference between (1) and (2) may in some instances be negligible and in others appreciable. The ratings are made taking into consideration the most commonly used materials of each type. Special formulas under any one type might change the order of suitability. Thus, exact technical interpretation of it should be avoided. After using it as a guide, "stop, look and listen" by examining closely the detailed technical data published elsewhere on each specific group of materials before proceeding. Remember that progress is being made constantly in improving the properties of practically all plastics.

The ratings given in the Comparator may not in all instances confirm published data, including that appearing in this issue of *Chem. & Met.* The materials are rated here according to usage experience, as well as to test data. For example, urea on the basis of A.S.T.M. water absorption tests would warrant a better rating. However, on continuous exposure to high humidity or water, the rating shown in the Comparator is 8.

PLASTICS COMPARATOR

PLASTIC MATERIAL	Toughness (Impact Strength)	Flexural Strength	Tensile Strength	Color Stability	Cold Flow	Water Resistance	Acid Resistance	Caustic Resistance	Solvent Resistance	Dimensional Change on Aging	Heat Resistance (Continuous Heat)	Flammability	Heat Insulation	Specific Gravity	Hardness	Loss Factor	Resistivity	Dielectric Strength	Moldability Around Inserts
Phenolic: General Purpose	10	3	3	7	1	5	3	4	1	4	2	3	2	8	5	10	7	4	2
Phenolic: Low-Loss	11	3	7	7	1	2	4	4	1	2	3	1	7	12	3	4	3	3	2
Phenolic: Heat-Resistant	9	4	8	7	1	2	4	4	1	1	1	1	7	13	2	○	8	8	2
Phenolic: Acid and Alkali-Resistant	10	6	8	7	1	3	2	3	1	5	3	2	2	5	4	○	○	7	3
Phenolic: Shock-Resistant	2	1	5	7	1	6	4	5	1	6	3	4	3	10	5	○	9	8	1
Phenolic: Transparent	7	1	3	7	1	3	3	3	1	5	3	2	2	6	4	7	5	6	3
Urea	8	1	1	1	2	8	4	4	1	7	7	5	5	11	1	9	4	2	4
Polystyrene	7	2	7	4	4	1	1	1	3	3	6	6	1	1	6	1	1	1	6
Cellulose-Acerate	4	6	9	3	8	10	4	6	3	9	5	6	4	7	9	8	6	5	5
Aceto-Butyrate	1	5	10	3	6	7	4	4	3	8	4	6	6	4	8	3	○	○	5
Ethyl-Cellulose	3	2	6	6	7	9	4	2	3	8	5	6	4	2	8	2	2	1	5
Methyl-Methacrylate	6	1	4	2	5	4	2	2	3	8	9	6	2	3	7	5	○	2	6
Vinyl (No Filler)	5	1	2	5	3	1	1	1	2	3	8	5	2	9	7	6	2	1	5

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Effect on Plastics of Immersion for 7 Days in Chemical Reagents at 25 Deg. C.

	Phenol-Formaldehyde Molded	Phenol-Formaldehyde Cast	Phenol-Formaldehyde Laminated	Urea-Formaldehyde Molded	Urea-Formaldehyde Laminated	Vinyl Chloride-Acetate Resin	Vinyl Butyral Resin	Methyl Methacrylate Resin	Styrene Resin Molded	Cellulose Nitrate	Cellulose Acetate	Ethyl-Cellulose No. 1	Cold-Molded Phenolic	Casein Plastic
30% Sulphuric acid	Surface roughened	None	Edges swollen	Surface roughened	Surface attacked	None	None	None	None	None	Crazed; softened	None	None	Rubbery
3% Suphuric acid	Surface roughened	None	Edges swollen	Surface roughened	Surface attacked	None	Cloudy	None	None	None	Swollen	None	None	Swollen; rubbery
10% Nitric acid	Surface roughened	None	Edges swollen	Surface roughened	Delaminated	None	Cloudy	None	None	None	Decomposed	None	None	Swollen; cracked
10% Hydrochloric acid	Surface roughened	None	Edges swollen	Surface roughened	Delaminated	None	Cloudy	None	None	None	Decomposed	None	Cracked on drying	Swollen: cracked
5% Acetic acid	None	None	Edges swollen	None	None	None	Cloudy	None	None	None	Swollen	None	None	Rubbery; split
Oleic acid	None	None	None	None	None	None	Tacky	None	None	None	None	Decomposed	None	None
10% Sodium hydroxide	Decomposed	Decomposed	Delaminated	None	Surface attacked	None	None	None	None	Crazed	Decomposed	None	Decomposed	Decomposed
1% Sodium hydroxide	Surface roughened	Decomposed	Edges swollen	None	None	None	Slightly cloudy	None	None	Crazed	Surface attacked	None	Decomposed	Broken up

(Continued on next page)

Effect on Plastics of Immersion for 7 Days in Chemical Reagents at 25 Deg. C. (Cont'd.)

	Phenol-Formaldehyde Molded	Phenol-Formaldehyde Cast	Phenol-Formaldehyde Laminated	Urea-Formaldehyde Molded	Urea-Formaldehyde Laminated	Vinyl Chloride-Acetate Resin	Vinyl Butyral Resin	Methyl Methacrylate Resin	Styrene Resin Molded	Cellulose Nitrate	Cellulose Acetate	Ethyl-Cellulose No. 1	Cold-Molded Phenolic	Casein Plastic
10% Ammonium hydroxide	Surface dulled	Discolored	Discolored; edges swollen	None	None	None	Opaque	None	Discolored	Crazed; discolored	Opaque; soft	None	None	Swollen; split
2% Sodium carbonate	None	Discolored	Discolored	None	None	None	Slightly cloudy	None	None	None	Swollen	None	None	Swollen; rubbery
10% Sodium chloride	None	None	Edges swollen	None	None	None	None	None	None	None	None	None	None	None
3% Hydrogen peroxide	None	Discolored	None	Surface dulled	Delaminated	None	Cloudy	None	None	None	None	None	None	Swollen; rubbery
Distilled water	None	None	None	None	None	None	Cloudy	None	None	None	None	None	None	Swollen; rubbery
50% Ethyl alcohol	None	None	None	None	None	None	Swollen; rubbery	Slightly swollen	None	None	Partly dissolved	Swollen; cracked	None	Swollen; rubbery
95% Ethyl alcohol	None	None	None	None	None	None	Dissolved	Surface attacked	None	Dissolved	Partly dissolved	Dissolved	None	None
Acetone	None	Softened	Blistered	None	None	Dissolved	Swollen; opaque	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	None	None
Ethyl acetate	None	None	None	None	None	Decomposed	Decomposed	Dissolved	Dissolved	Dissolved	Dissolved	Dissolved	None	None
Ethylene chloride	None	None	None	None	None	Dissolved	Decomposed	Dissolved	Dissolved	Partly dissolved	Soft; swollen	Dissolved	None	None
Carbon tetrachloride	None	None	None	None	None	None	Swollen; rubbery	Surface attacked	Dissolved	None	None	Dissolved	None	None
Toluene	None	None	None	None	None	Soft; rubbery	Swollen; rubbery	Dissolved	Dissolved	Partly dissolved	None	Dissolved	None	None
Gasoline	None	None	None	None	None	None	None	None	Partly dissolved	None	None	Swollen; cracked	None	None

From a paper, Resistance of Plastics to Chemical Reagents, by G. M. Kline, R. C. Rinker and H. F. Meindl presented before Chicago meeting of A.S.T.M. June 24, 1941.

Properties of Phenol-Formaldehyde-Asbestos Plastics

Properties	Haveg 41	Haveg 43	Haveg 50
Specific gravity	1.6	1.6	1.6
Tensile strength, psi	2,500	2,500	1,800
Compressive strength, psi	10,500	8,000	6,000
Flexural strength, psi	5,600	4,500	3,500
Shearing strength, psi	3,500	3,000	2,500
Modulus of elasticity	1,000,000	850,000	.....
Thermal conductivity BTU/sq.ft./°F./hr./ft.	0.203	0.607	0.203
Coefficient of expansion Inches per inch of length or per deg. F.	0.000018 (18×10^{-6})		
Feet per foot of length per deg. C.	0.000033 (33×10^{-6})		

Chemical Resistance of Phenol-Formaldehyde-Asbestos Plastics (Haveg types)

Corrosive Materials	Recommended Grade	Also Satisfactory	Not Satisfactory
Acetic acid	41	43	50
Alcohol	41	43	50
Aluminum chloride	41	43-50	....
Aluminum sulphate	41	43-50	....
Ammonium chloride	41	43-50	....
Ammonium hydroxide	41	43-50	....
Ammonium sulphate	41	43-50	....
Aniline hydrochloride	41	43	....
Benzol	41	43	50
Boric acid	41	43-50	....
Calcium chloride	41	43-50	....
Carbon tetrachloride	41	43	....
Chlorine gas	41	43	....
Chlorine water	41	43	....
Citric acid	41	43	....
Copperas	41	43-50	....
Copper sulphate	41	43-50	....
Cupric chloride	41	43-50	....
Ferric salts	41	43-50	....
Ferrous salts	41	43-50	....
Fluosilicic acid	43	....	41-50
Formic acid	41	43	....
Gasoline (sour)	41	43	50
Hydrobromic acid	41	43-50	....
Hydrochloric acid	41	43-50	....
Hydrofluoric acid	43	....	41-50
Hydrofluosilicic acid	43	....	41-50
Hydrogen sulphide	41	43-50	....
Lactic acid	41	43	....
Lead acetate	41	43-50	....
Muriatic acid	41	43-50	....
Oxalic acid	41	43-50	....
Phosphoric acid	41	43-50	....
Potassium bisulphate	41	43-50	....
Potassium chloride	41	43-50	....
Potassium hydroxide	50	....	41-43
Potassium sulphate	41	43-50	....
Salt brine	41	43-50	....
Sodium acid sulphate	41	43-50	....
Sodium bicarbonate	41	43-50	....
Sodium bisulphate	41	43-50	....
Sodium carbonate	41	43-50	....
Sodium hydroxide	50	....	41-43
Sodium sulphate	41	43-50	....
Sodium sulphite	41	43-50	....
Sodium thiosulphate	41	43-50	....
Sulphur dioxide	41	43-50	....
Sulphuric acid (up to 50%)	41	43-50	....
Sulphurous acid	41	43-50	....
Tannic acid	41	43-50	....
Tartaric acid	41	43	....
Tin chloride	41	43-50	....
Trisodium phosphate	41	43-50	....
Vinegar	41	43-50	....
Zinc chloride	41	43-50	....
Zinc sulphate	41	43-50	....

Chemical Resistance of Phenol-Formaldehyde-Fiber Glass Plastics

Chemical resistance: Chlorine and its compounds, hydrochloric acid, dilute sulphuric acid, phosphoric acid, organic acids, solvents, trichlorethylene, carbon tetrachloride ethylene, chlorhydrin, hydrocarbons, metal salt solutions etc.

Physical properties: Specific gravity 1.35. Tensile strength 36,000 lb. per sq. in. Impact strength 16 ft. lb. per inch of notch. The material may be used for working temperatures up to 275 deg. F.

Available Forms: Pipes and fittings, rectangular and cylindrical tanks, and other large-size chemical plant equipment.

Data supplied for Corrosite by S. Blickman, Inc., Weehawken, N. J.

Chemical Properties of Acrylic Plastics[1]

Immersion Solution[2]	Percent Weight Gain[3]
30% Sulphuric acid	0.6
3% Sulphuric acid	1.0
10% Hydrochloric acid	0.7
10% Sodium hydroxide	0.8
1% Sodium hydroxide	1.0
10% Nitric acid	0.9
5% Acetic acid	1.0
2% Sodium carbonate	1.0
10% Sodium chloride	0.9
10% Ammonium hydroxide	0.9
3% Hydrogen peroxide	1.0
100% Distilled water	0.9

[1] Approved tests of the Committee on Plastics of the American Society for Testing Materials using pieces of material 1 in. x 3 in. x 0.125 in. totally immersed in the various chemical solutions for 192 hr. at 25° C. Data supplied for Plexiglas by Rohm & Haas Co., Philadelphia, Pa.

[2] All concentrations given in percent by weight in distilled water.

[3] A gain in weight of one percent or less is considered negligible except in unusual applications. None of the above solutions appreciably affects the appearance or strength characteristics.

Chemical Resistance of Cellulose Acetate Molding Materials*

	Class I	Class II
Average Water Absorption — (Injection molded bar 5 in. x ½ in. x ¼ in.)	Percent	Percent
24 hours	2.00	1.50
48 hours	2.75	2.00
96 hours	3.75	2.70
Acids and Alkalies — Dilute	Slight effect	Slight effect
Concentrated	Decomposes	Decomposes
Effect of: Time	Slight on aging	Slight on aging
Sunlight	Slight	Slight
Heat	Slow burning rate	Slow burning rate

Solvents — Both Class I and Class II are soluble in ketones and esters, i.e., acetone, methyl acetate, the "Cellosolve" solvents affected slightly by alcohol. Insoluble in hydrocarbons, i.e., benzene, toluene, styrene, carbon tetrachloride and oils. Elevated temperatures influence the action of both solvents and non-solvents inducing swelling.

Chemical Resistance of Polystyrene Molding Materials*

Resistance to Non-Oxidizing Acids — Excellent
Resistance to Oxidizing Acids — Discolors Slightly
Resistance to Alkalies — Excellent
Resistance to Hydrochloric Acid — Good

Dissolved or Attacked by:

Styrene	Toluene	Ethyl Acetate	Ethyl Benzene	"Cellosolve" Acetate	Gasoline
Benzene	Dioxane	Turpentine	Ethylene Chloride	Carbon Tetrachloride	"Cellosolve" Solvent

Unaffected by:

Acetic Acid	Sodium Hydroxide (30%)	Salt Water
Formic Acid	Potassium Hydroxide (30%)	Bleaching Solutions
Butanol	Ethylene Diamine	Photographic Chemicals
Octyl Alcohol	Writing Inks	Most fats, animal and vegetable oils

Chemical Resistance of Vinyl Copolymer Injection Molding Compounds

Reagent	Reaction	Reagent	Reaction
Weak acids	Excellent	Esters	Poor — dissolves
Strong acids	Excellent	Aromatic hydrocarbons	Poor — swells
Weak alkalis	Excellent	Aliphatic hydrocarbons	Excellent
Strong alkalis	Excellent	Mineral oils	Excellent
Alcohols	Excellent	Animal oils	Excellent
Ketones	Poor — dissolves	Vegetable oils	Excellent

*Data supplied by Bakelite Corporation, New York.

Chemical Resistance of Saran Pipe at Room Temperature After Three Months.

Reagent	Stability Rating
98% (Conc.) H_2SO_4	Good
60% H_2SO_4	Excellent
30% H_2SO_4	Excellent
10% H_2SO_4	Excellent
35% (Con c.) HCl	Excellent
10% HCl	Excellent
65% (Conc.) HNO_3	Excellent
10% HNO_3	Excellent
Glacial acetic	Excellent
10% Acetic	Excellent
5% H_2SO_3	Excellent
50% NaOH	Fair
10% NaOH	Good
28% NH_3	Unsuitable
10% NH_3	Poor
Ethyl alcohol	Excellent
Ethyl acetate	Fair
Acetone	Fair
Methyl iso-butyl ketone	Fair
Carbon tetrachloride	Good
Ethylene dichloride	Poor
Di-ethyl ether	Poor
Dioxane	Unsuitable
Benzene	Fair
O-dichlor benzene	Poor
Triethanolamine	Excellent
Bromine water	Unsuitable
Chlorine water	Unsuitable
Bleaching solution	Excellent
10% Zinc hydrosulphite	Excellent
15% $CaCl_2$	Excellent
15% $FeSO_4$	Good
Water	Excellent
Air	Excellent

GLASS, GLASS-LINED AND FUSED SILICA

Physical Properties of Low-Expansion Glasses, Fused Quartz and Fused Silica

MATERIAL	Specific Gravity	Specific Volume, Cu. in. per lb.	Tensile Strength, Lb. per sq. in.	Modulus of Elasticity, Lb. per sq. in. (Multiply by 10^6)	Hardness*	Thermal Expansion Per °C. (Multiply by 10^{-7})	Thermal Cond., Cal. per sec., cm^2, °C., cm. (Multiply by 10^4)	Specific Heat, Cal. per °C., gm.	Softening Point, °F.	Breakdown Voltage, 60 cycles, v. per mil	Dielectric Constant, 60 cycles	Refractive Index, n_D	Transparency†	Forms Available**
Borosilicate glass	2.23	12.4	10,000	98	....	0.32	24.5	0.20	1,505	3,200 (0.1 in.)	4.6	1.47	T, TL	S, R, T, other
96% silica glass	2.18	12.7	.....	.....	...	0.080	...	.....	2,750±90	3,000	4.0	1.458	T	R, T, other
Fused quartz	2.20	12.6	4,000	105–126	4.9	0.054	3.5	0.25	2,600	500 (¼ in.)	Approx. 3.8	1.459	T	S, R, T, other
Fused silica	2.07	13.4	400–800	94–114	....	0.054	25	.....	2,600	250 (¼ in.)	3.7	....	TL, O	S, R, T, other

* Hardness: 2.5 mm. ball, 25 kg. load, depth in 1/200 mm. † T = transparent; TL = translucent; O = opaque. ** S = sheets; R = rods; T = tubes.

Makers of Glass, Glass-Lined and Fused Silica Equipment

MANUFACTURER (Name and Address)	Composition, Forms Available	MANUFACTURER (Name and Address)	Composition, Forms Available
Alsop Engineering Co., Milldale, Conn.	Glass-lined steel tanks and mixers	Hanovia Chemical & Mfg. Co., Newark, N. J.	Transparent fused quarts in all shapes
Amersil Corp., Hillside, N. J.	Fused silica ware such as pans, pipes, gas coolers, absorbers	Metal-Glass Products Co., Belding, Mich.	Glass-enameled steel equipment
Corning Glass Works, Corning, N. Y.	Special heat- and corrosion-resisting borosilicate glass supplied in various forms: pipe, columns, etc. Also 96 per cent high silica glassware now available for laboratory use	Owens-Corning Fiberglas Corp., Toledo, Ohio	Fibrous glass filter cloths and dust filters
		The Pfaudler Co., Rochester, N.Y.	Wide variety of standard and special glass-enameled steel equipment — various formulas
		A. O. Smith Corp., Milwaukee, Wis.	Glass-enameled steel equipment
		The Thermal Syndicate, Brooklyn, N. Y.	Fused silica (non-transparent) supplied in various large forms; fused quartz (transparent) in smaller sizes
Ertel Engineering Co., New York, N. Y.	Glass-enameled tanks		
General Electric Co., Schenectady, N. Y.	Transparent fused quarts in various small sized articles	Vitreous Enameling & Stamping Co., New York, N. Y.	Enameled specialties, tanks
Glascote Products, Inc., Euclid, Ohio	Glass-enameled steel equipment	Vitreous Steel Products Co., Cleveland, Ohio	Enameled trays and specialties

WOOD FOR CHEMICAL EQUIPMENT

Physical Properties of Woods Commonly Used for Equipment and Plant Structures

	Cypress	Douglas Fir (Coast)	L. L. Y. Pine	Redwood	Sugar Maple	White Oak
Lb. per cu. ft. (12% moisture)	32	34	41	28	44	47
Tensile str., * lb. per sq. in. (12% moisture)	7,200	8,100	9,300	6,900	9,500	7,900
Compressive str., * lb. per sq. in. (12% moisture)	4,740	6,450	6,150	4,560	5,390	4,350
Thermal cond., B.t.u. per sq. ft., hr., ° F., in.	0.83	0.77	0.96	0.76	1.16	1.22
Hardness	Med.	Med.	Hard	Mod. hard	Med.	Hard

*At proportional limit, in static bending, and compression parallel to grain, respectively.

Condition of Woods After 31 Days' Immersion in Cold Solutions*

(Examined after 7 days drying)

	Fir	Oak	Oregon Pine	Yellow Pine	Spruce	Redwood	Maple	Cypress
Hydrochloric Acid, 5%	NAC	NAC	NAC	SS	SS	SS	NAC	NAC
Hydrochloric Acid, 10%	NAC	NAC	NAC	SS	SS	SS	NAC	NAC
Hydrochloric Acid, 50%	SS,SB,SWF	SS,WF	S,WF	S,WF	S,WF	S,WF	S,WF	S,WF
Sulphuric Acid, 1%	NAC	NAC	NAC	SS	SS	NAC	NAC	SS,SB
Sulphuric Acid, 5%	SS	SS	SS	SS	SS,SB	SS,SB	NAC	SS,SB
Sulphuric Acid, 10%	S,FSD	S,FSD	S,FSD	S,FSD	S,FSD	S,FSD	S,FSD	S,FSD
Sulphuric Acid, 25%	SSp,FSD	SSp,FSD	SSp,FSD	SSp,FSD	SSp,FSD	SSp,FSD	SSp,FSD	SSp,FSD
Caustic Soda, 5%	S,NAC	MSh,SWp	SS	SS,FSD	SSp,FSD	SSp,FSD	MSh	SSp,FSD
Caustic Soda, 10%	S,FSD	MSh,WF,Horny	SS	SS,SB,FSD	SS,St,FSD	SS,SB,FSD	MSh	S,SB,FSD
Alum, 13%	NAC	NAC	NAC	NAC	NAC	NAC	NAC	NAC
Sodium Carbonate, 10%	SB,GC	NAC	GC	SB,GC	SB,GC	SB,GC	GC	SB,GC
Calcium Chloride, 25%	NAC	NAC	NAC	NAC	NAC	NAC	NAC	NAC
Common Salt, 25%	NAC	NAC	NAC	SS,GC	SS,GC	SB,GC	NAC	NAC
Water	NAC	NAC	NAC	NAC	NAC	NAC	NAC	NAC
Sodium Sulphide	SS,SB	MSh,WF	SB	SB	SB	SB	MSh,FSD	FSD

Condition of Woods After 8 Hours Boiling in Solutions*

(Examined after 7 days drying)

	Fir	Oak	Oregon Pine	Yellow Pine	Spruce	Redwood	Maple	Cypress
Hydrochloric Acid, 10%	SB,S	FSD	FSD	FSD	FSD	FSD	FSD	FSD
Hydrochloric Acid, 50%	FD,Ch,B,S,NG	FD,Ch,B,S,NG	FD,Ch,B,S,NG	FD,Ch,B,S,NG	FD,Ch,B,S,NG	FD,Ch,B,S,NG	FD,Ch,B,S,NG	FD,Ch,B,S,NG
Sulphuric Acid, 4%	SB,GC	SB,GC	SB,GC	SB,GC	SB,GC	SB,GC	SB,GC	SB,GC
Sulphuric Acid, 5%	SS,GC	SB,GC	SB,GC	SB,GC	SB,FSD	SB,GC	SB,GC	SB,FSD
Sulphuric Acid, 10%	SS,GC	BFD,Wpd,NG	Sp,FD,NG	B,Sp,FD,NG	B,Sp,FD,NG	SB,FSD	SB,FSD	B,FD
Caustic Soda, 5%	SS	MSh	S	GC	S,GC	S,GC	Sh	SSp
Alum, 13%	SB,GC	NAC	NAC	SB,GC	SB,GC	SB,GC	NAC	SB,GC
Sodium Carbonate, 10%	SB,GC	GC	GC	GC	GC	GC	GC	SB,GC
Calcium Chloride, 25%	SB,GC	SB,SS,GC	NAC	SB,GC	SB,GC	NAC	NAC	SB,GC
Common Salt, 25%	NAC	NAC	NAC	SB,GC	NAC	SB,GC	NAC	NAC
Water	NAC	NAC	NAC	SB,GC	NAC	NAC	NAC	NAC

* The two tables describing the condition of eight varieties of woods used for tanks and other chemical-resistant uses are based on a report of James K. Stewart, consulting chemist, to the Mountain Copper Co., Martines, Calif. Tests were conducted on samples 1 x 4 x ¼ in. in size, seasoned and chosen so as to be as nearly as possible in the same physical condition as the woods would be when used for equipment construction. Results of the tests are described by terms explained in the following key:

Abbreviation Key

B — Brittle
Ch — Charred
FD — Fiber Disintegrated
FSD — Fiber Slightly Disintegrated
GC — Good Condition
MSh — Much Shrunk
NAC — No Apparent Change
NG — No Good
S — Softer
SB — Slightly Brittle
Sh — Shrunk
Sp — Spongy
SS — Slightly Softer
SSp — Slightly Spongy
SWF — Slightly Weakened Fiber
SWp — Slightly Warped
WF — Weakened Fiber
Wpd — Warped

Representative Makers of Wood Tanks and Pipe for Chemical Applications

Acme Tank Co., New York, N. Y.
Alert Pipe & Supply Co., Bay City, Mich.
Atlantic Tank Corp., North Bergen, N. J.
Axtell Co., Fort Worth, Texas
Baltimore Cooperage Tank & Tower Co., Baltimore, Md.
Black, Sivalls & Bryson, Inc., Oklahoma City, Okla.
C. F. Braun & Co., Alhambra, Calif.
W. E. Caldwell Co., Louisville, Ky.
Challenge Co., Batavia, Ill.
Caspar Lumber Co., Hobart Bldg., San Francisco, Calif.
A. J. Corcoran, Inc., Jersey City, N. J
Cypress Tank Co., Shreveport, La.
Dempster Mill Mfg. Co., Beatrice Neb.
Drane Tank Co., Fort Worth, Texas
Drummond Mfg. Co., Louisville, Ky
Dunck Tank Works, Inc., Milwaukee, Wis.
G. Elias & Bro., Buffalo, N. Y.
Engle Tank Co., Chicago, Ill.
Federal Pipe & Tank Co., Seattle
Fleming Tank Co., Pittsburgh, Pa.
Fluor Corp., Ltd., Los Angeles
Fibre Conduit Co., Orangeburg, N. Y
Foster Wheeler Corp., New York
General Tank Corp., Kearny, N. J.
Amos H. Hall & Sons, Philadelphia
Harry Cooling & Equipment Co., Doylestown, Pa.
Hauser-Stander Tank Co., Cincinnati, Ohio
Hammond & Little River Redwood Co., Samoa, Calif.
Henderson Bros. Co., Waterbury
R. R. Howell & Co., Minneapolis
James Hunter Machine Co., North Adams, Mass.
Johnson & Carlson, Chicago, Ill.
Kalamazoo Tank & Silo Co., Kalamazoo, Mich.
Lincoln Tank Co., Shreveport, La.
Lille-Hoffman Cooling Towers, Inc., St. Louis, Mo.
Marley Co., Kansas City, Kan.
Michigan Pipe Co., Bay City, Mich.
National Tank Co., Tulsa, Okla.
National Tank & Pipe Co., Portland, Oregon
New England Tank & Tower Co., Everett, Mass.
Pacific Cooperage Co., Portland, Oregon
Pacific Wood Tank Corp., San Francisco, Calif.
Pacific Tank & Pipe Co., Oakland Calif.
Parkersburg Rig & Reel Co., Parkersburg, West Va.
Fred C. Pfeil, Inc., Buffalo, N. Y.
J. F. Pritchard & Co., Kansas City, Mo.
Redwood Mfrs. Co., San Francisco, Calif.
Wm. B. Scaife & Sons Co., Pittsburgh Dist., Oakmont, Pa.
Schubert-Christy Corp., St. Louis
A. T. Stearns Lumber Co., Boston
Treadwell Construction Co., Station A., Midland, Pa.
Union Lumber Co., Crocker Bldg. San Francisco, Calif.
U. S. Wind Engine & Pump Co., Batavia, Ill.
Wendnagel Co., Chicago, Ill.
C. H. Wheeler Mfg. Co., North Phila., Pa.
G. Woolford Wood Tank Co., Darby, Pa.
A. Wyckoff & Son Co., Elmira, N. Y.

Continued

Metals and Alloys for Const

No	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities [1]	Methods of Fabrication	Forms Available	Temp.
43	CE-30 Stainless Steel, cast	Note: These are the standard designations of cast compositions for nickel-chromium alloys published by the Alloy Casting Institute. The recommended uses have been assembled from published data of individual producers. These compositions are available from one or more of the following foundries: Allegheny Ludlum Steel Corp., Pittsburgh, Pa. American Manganese Steel Div. of the American Brake Shoe & Fdry. Co., Chicago Heights, Ill. American Steel Castings Co., Newark, N. J. Atlas Foundry Co., Irvington, N. J. Babcock & Wilcox Co., Barberton, Ohio Chicago Steel Foundry, Chicago, Ill. Cooper Alloy Foundry Co., Elizabeth, N. J. Crane Co., Chicago, Ill. Driver Harris Co., Harrison, N. J. Duraloy Co., Scottdale, Pa. Duriron Co., Inc., Dayton, Ohio Electric Steel Foundry Co., Portland, Ore. Electro-Alloys Co., Elyria, Ohio Empire Steel Castings, Inc., Reading, Pa. General Alloys Co., Boston, Mass. Hoskins Mfg. Co., Detroit, Mich. Lebanon Steel Foundry, Lebanon, Pa. Michiana Products Corp., Michigan City, Ind. Michigan Steel Casting Co., Detroit, Mich. Midvale Co., Philadelphia, Pa. National Alloy Div. of the Blaw-Knox Co., Blawnox, Pa. Ohio Steel Foundry Co., Lima and Springfield, Ohio Otis Elevator Co., Buffalo, N. Y. Sivyer Steel Casting Co., Milwaukee, Wis. Standard Alloy Co., Cleveland, Ohio Symington-Gould Corp., Rochester, N. Y. Taylor Wharton Iron & Steel Co., High Bridge, N. J. Warman Steel Casting Co., Huntington Park, Calif. Utility Electric Steel Foundry, Los Angeles, Calif.	Fe; Cr, 27–30; Ni, 8–11; C, 0.30 max.	Fair		Castings	Room
44	CF-7 Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.	Fair		Castings	Room
45	CF-10 Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.10 max.	Fair		Castings	Room
46	CF-16 Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.16 max.	Good	B, F, R, W	Castings	Room
47	CF-20 Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.20 max.	Fair		Castings	
48	CF-7Se Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Se, 0.20–0.35			Castings	
49	CF-7C Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Cb, 10XC		R, W	Castings	Room
50	CF-7M Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Mo, 2.5–3.5	Fair		Castings	Room Boiling
51	CF-10M Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.10 max.; Mo, 2.5–3.5	Poor	B, W	Castings	
52	CF-16M Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.16 max.; Mo, 2.5–3.5			Castings	Room Boiling
53	CF-7MC Stainless Steel, cast		Fe; Cr, 18–20; Ni, 8–10; C, 0.07 max.; Mo, 2.5–3.5; Cb, 10XC			Castings	
54	CG-7 Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.	Poor	F, R, W	Castings	Room
55	CG-10 Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.10 max.	Good	B, F, R, W	Castings	Room
56	CG-16 Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.16 max.			Castings	
57	CG-16Se Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.16 max.; Se, 0.20–0.35			Castings	
58	CG-7C Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.; Cb, 10XC	Good	F, R, W	Castings	Room Boiling
59	CG-7M Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.; Mo, 2.5–3.5			Castings	
60	CG-10M Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.10 max.; Mo, 2.5–3.5	Good	B, F, R, W	Castings	Room
61	CG-16M Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.16 max.; Mo, 2.5–3.5		R, W	Castings	Room Boiling
62	CG-7MC Stainless Steel, cast		Fe; Cr, 20–22; Ni, 10–12; C, 0.07 max.; Mo, 2.5–3.5; Cb, 10XC			Castings	
63	CH-10 Stainless Steel, cast		Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.		R, W	Castings	Room
64	CH-20 Stainless Steel, cast		Fe; Cr, 23–26; Ni, 10–12; C, 0.20 max.	Fair		B, C	Room
65	CH-10C Stainless Steel, cast		Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.; Cb, 10XC			Castings	
66	CH-10M Stainless Steel, cast		Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.; Mo, 2.5–3.5	Fair	W	Castings	Room
67	CH-20M Stainless Steel, cast		Fe; Cr, 23–26; Ni, 10–12; C, 0.20 max.; Mo, 2.5–3.5	Fair		B, C	Room Boiling
68	CH-10MC Stainless Steel, cast		Fe; Cr, 23–26; Ni, 10–12; C, 0.10 max.; Mo, 2.5–3.5; Cb, 10XC			Castings	
69	CK-25 Stainless Steel, cast		Fe; Cr, 23–26; Ni, 19–21; C, 0.25 max.		R, W	Castings	Room
70	CM-25 Stainless Steel, cast		Fe; Cr, 8–11; Ni, 19–21; C, 0.25 max.			Castings	
71	HB Stainless Steel, cast		Fe; Cr, 18–22; Ni, 2 max.			Castings	
72	HC Stainless Steel, cast		Fe; Cr, 27–30; Ni, 3 max.	Fair		Castings	
73	HD Stainless Steel, cast		Fe; Cr, 27–30; Ni, 3–6			Castings	
74	HE Stainless Steel, cast		Fe; Cr, 27–30; Ni, 8–11			Castings	
75	HH Stainless Steel, cast		Fe; Cr, 23–27; Ni, 10–13	Fair		Castings	
76	HK Stainless Steel, cast		Fe; Cr, 23–26; Ni, 19–21	Good	W	Castings	
77	HL Stainless Steel, cast		Fe; Cr, 28–32; Ni, 19–21			Castings	
78	HP Stainless Steel, cast		Fe; Cr, 28–32; Ni, 29–31			Castings	
79	HS Stainless Steel, cast		Fe; Cr, 8–12; Ni, 29–32			Castings	
80	HT Stainless Steel, cast		Fe; Cr, 13–17; Ni, 34–37	Good		Castings	
81	HU Stainless Steel, cast		Fe; Cr, 17–21; Ni, 37–40	Good	W	Castings	
82	HW Stainless Steel, cast		Fe; Cr, 10–14; Ni, 59–62	Good		Castings	Room Boiling
83	HX Stainless Steel, cast		Fe; Cr, 15–19; Ni, 65–68	Good		Castings	

[1] Stable solutions only. [2] Depending on service. [3] Composition given is for castings. [4] Higher carbon if specified. [5] With molybdenum.

ys for Construction of Chemical Engineering

Forms Available	Sulphuric Acid							Hydrochloric Acid						Nitric Acid					Acet	
	Temp.	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	20%	Conc.	Temp.	0.5%	5%	20%	65%	Temp.	0.5%
Castings	Room	R	R.004	.03				Room		.08				Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings	Room	R	R 0.2	0.7				Room	R					Room Boiling	R R	R R	R R	R R .008	Room Boiling	R R
Castings	Room	R[5]	R[5]	R[5]				Room	R	R				Room Boiling	R R	R R	R R	R R	Room Boiling	R[5] R[5]
Castings	Room	R	R	R				Room	R	R				Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings														Room Boiling	R R	R R	R R	R R	Room Boiling	
Castings																				
Castings	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings	Room Boiling	R	R .002 R	R .003			R	Room	R	R .0007				Room Boiling	R R	R R	R R	R R .018	Room Boiling	R R
Castings																				
Castings	Room Boiling	R R	R		R	R	R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings																				
Castings	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room	R
Castings	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings																				
Castings																				
Castings	Room Boiling	R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings																				
Castings	Room	R	R	R	R	R	R	Room	R	R				Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings	Room Boiling	R R	R		R	R	R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
Castings																				
Castings	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room	R
B, C	Room	R	R .0025	R .005				Room	R	.06				Room Boiling	R R	R R	R R	R R .009	Room Boiling	R R
Castings																				
Castings	Room	R<.004	R<.004	R<.004	R<.004	R<.004	R<.004	Room Boiling	R R	R R .0030				Room Boiling	R R	R R	R R	R R.0180	Room Boiling	R R
B, C	Room Boiling	R R	R .0001 .08	R .001 .4			R	Room Boiling	R R	R .0001 R .004				Room Boiling	R R	R R	R R	R R .01	Room Boiling	R R
Castings																				
Castings	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room	R
Castings																				
Castings																				
Castings														Room Boiling	R R	R R	R R	R R		
Castings														Room Boiling	R R	R R	R R	R R	Room	R
Castings																				
Castings	Furnace parts, tube supports and other heat resistant parts													Room Boiling	R R	R R	R R	R R	Room	
Castings	Used for its resistance to high temperatures																			
Castings																				
Castings																				
Castings																				
Castings	Used primarily for high-temperature applications																			
Castings	Used primarily for heat resistance																			
Castings	Room Boiling	R R	R R	R	R	R	R	Room Boiling	R R	R R	R	R	R	Room Boiling	R R	R R	R	R	Room Boiling	R R
Castings	Primarily for high-temperature applications													Room Boiling	R R	R R	R R	R R	Room	R

ng Equipment

Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
Temp.	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
oom oiling	R R	R R	R	R .035	Room	R	R	R	Room Boiling	R R	R R	R	Room	R		Good	Fair	43
oom oiling	R R	R R	R	R.0005 .09	Room Boiling	R R	R	R.001	Room Boiling	R R	R R	R	Room	R	R	Fair	Poor	44
oom oiling	R[5] R[5]	R[5] R[5]	R[5] R[5]	R[5] R[5]	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Fair	Fair	45
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Fair	Fair	46
oom oiling		R R							Room Boiling	R R						Fair	Poor	47
																		48
oom oiling	R R	R R			Room	R	R	R	Room Boiling	R	R	R R				Fair	Fair	49
oom oiling	R R	R R	R R	R.0001 R.003	Room Boiling	R R	R R	R.0002	Room Boiling	R R	R R	R R	Room	R	R	Fair	Poor	50
																Fair	Fair	51
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R		Room	R	R	Good	Good	52
																		53
oom	R	R	R	R	Room	R	R	R	Room Boiling	R R	R R		Room	R				54
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R R				Fair	Fair	55
																		56
																		57
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Fair	Fair	58
																		59
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Fair	Fair	60
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R		Room	R	R			61
																		62
oom	R	R	R	R														63
oom oiling	R R	R R	R	R .06	Room Boiling	R R	R	R	Room Boiling	R R	R R	R R	Room Boiling	R R		Good	Fair	64
																		65
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R R				Fair	Good	66
oom oiling	R R	R R	R R	R R.0017	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R R	Room Boiling	R R	R	Good	Fair	67
																		68
oom	R	R	R	R					Room Boiling	R R	R R	R R	Room	R		Fair	Fair	69
																		70
																		71
					Room	R										Good	Good	72
oom	R	R	R	R	Room	R	R	R										72
																		74
oom		R							Room Boiling	R R						Good	Fair	75
																Good	Poor	76
																		77
																		78
																		79
																Good	Fair	80
																Good	Good	81
oom oiling	R R	R R	R R	R R	Primarily for heat resistance				Room Boiling	R R	R R	R R				Good	Fair	82
oom	R	R	R	R	Room	R	R	R	Room Boiling	R R	R R	R				Good	Fair	83

Terms Used

Composition

"Essential nominal chemical composition" refers to the principal constituents and the approximate proportion present. When "Fe" is shown without percentage it may be assumed that it represents the balance of the composition.

Forms Available

B = bars
C = castings
CR = cold rolled
D = drawn
HR = hot rolled
P = plates
R = rods
S = sheets
T = tubes
W = wire

Methods of Fabrication

B = brazing
DD = deep drawing
F = flanging
R = riveting
W = welding

Corrosion Data

R indicates that the metal or alloy should give reasonably good resistance under the conditions of concentration and temperature specified, but it does not imply any guarantee of satisfactory service. The figures following the R are the reported result of laboratory corrosion test in inches penetration per year. Where space is left blank either there are insufficient data available to indicate the extent of resistance or more complete information concerning the service required is necessary.

Footnotes

Superior numbers refer to footnotes.

Metals and Alloys for Con

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities	Methods of Fabrication	Forms A
	FERROUS ALLOYS	Note: Physical and chemical properties for those stainless steels in *wrought* form which have been assigned type numbers by the American Iron & Steel Institute are grouped herewith at the suggestion of the Stainless Steel Technical Committee of the producers. These stainless steels in *wrought* form are generally available from the following producers: Allegheny-Ludlum Steel Corp., Pittsburgh, Pa. Alloy Metal Wire Co., Prospect Park, Pa. American Rolling Mill Co., Middletown, Ohio Babcock & Wilcox Tube Co., Beaver Falls, Pa. Bethlehem Steel Co., Bethlehem, Pa. A. M. Byers Co., Pittsburgh, Pa. Carpenter Steel Co., Reading, Pa. Cooper Alloy Fdry. Co., Elizabeth, N. J. Crucible Steel Co., New York, N. Y. Wilbur B. Driver Co., Newark, N. J. Firth Sterling Steel Co., McKeesport, Pa. Forging and Casting Corp., Ferndale, Mich. Henry Disston & Sons, Philadelphia, Pa. Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind. Jessop Steel Co., Washington, Pa. Latrobe Electric Steel Co., Latrobe, Pa. Michiana Products Corp., Michigan City, Ind. Midvale Co., Philadelphia, Pa. Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa. Timken Roller Bearing Co., Canton, Ohio Republic Steel Corp., Cleveland, Ohio Rustless Iron & Steel Corp., Baltimore, Md. Superior Steel Corp., Carnegie, Pa. United States Steel Corp., Pittsburgh, Pa. Universal Cyclops Steel Corp., Bridgeville, Pa. Vanadium Alloys Steel Co., Latrobe, Pa.			
1	**301 Stainless Steel, wrought**		Fe; Cr, 16–18; Ni, 6–8; C, 0.08–0.2; Mn, 2.0 max.	Fair	B, DD, F, R, W	B, CR, D, HR, I
2	**302 Stainless Steel, wrought**		Fe; Cr, 17–19; Ni, 8–10; C, > 0.08–0.20; Mn, 2.0 max.	Fair	B, DD, F, R, W	B, CR, D, HR, I
3	**302B Stainless Steel, wrought**		Fe; Cr, 17.0–19; Ni, 8–10; C, > 0.08; Si, 2–3; Mn, 2.0	Fair		B, CR, D, HR, I
4	**303 Stainless Steel, wrought**		Fe; Cr, 17–19; Ni, 8–10; C, 0.2 max.; S or Se, 0.07 min. or Mo, 0.60 max.	Good	B, W	B, CR, D, HR, I
5	**304 Stainless Steel, wrought**		Fe; Cr, 18–20; Ni, 8–10; C, 0.08 max.; Mn, 2.0 max.	Fair	DD, F, R, W	B, CR, D, HR, I
6	**308 Stainless Steel, wrought**		Fe; Cr, 19–22; Ni, 10–12; C, 0.08 max.; Mn, 2 max.	Poor	DD, F, R, W	B, CR, D, HR, I
7	**309 Stainless Steel, wrought**		Fe; Cr, 22–26; Ni, 12–15; C, 0.20 max.	Fair	B, DD, F, R, W	B, CR, D, HR, I
8	**309S Stainless Steel, wrought**		Fe; Cr, 22–26; Ni, 12–15; C, 0.08 max.			B, CR, D, HR, I
9	**310 Stainless Steel, wrought**		Fe; Cr, 23–26; Ni, 19–22; C, 0.25 max.	Fair	DD, F, R, W	B, CR, D, HR, I
10	**311 Stainless Steel, wrought**		Fe; Cr, 18–20; Ni, 24–26; C, 0.25 max.	Good	DD, F, R, W	B, CR, D, HR, I
11	**312 Stainless Steel, wrought**		Fe; Cr, 27–31; Ni, 8–10; C, 0.25 max.			B, D, P, S, W
12	**316 Stainless Steel, wrought**		Fe; Cr, 16–18; Ni, 10–14; C, 0.10 max.; Mo, 2–3	Fair	B, DD, F, R, W	B, CR, D, HR, I
13	**317 Stainless Steel, wrought**		Fe; Cr, 17.5–20; Ni, 10–14; C, 0.10 max.; Mo, 3–4	Fair	B, DD, F, R, W	B, CR, HR, P, R
14	**321 Stainless Steel, wrought**		Fe; Cr, 17–19; Ni, 8–12; C, 0.10 max.; Ti, min, 4xC	Fair	DD, F, R, W	B, CR, D, HR, I
15	**325 Stainless Steel, wrought**		Fe; Cr, 7–10; Ni, 19–23; C, 0.25 max.; Cu, 1–1.5		R, W	B, CR, D, HR, I
16	**327 Stainless Steel, wrought**		Fe; Cr, 25–30; Ni, 3–5; C, 0.25 max.			B, CR, D, HR, I
17	**329 Stainless Steel, wrought**		Fe; Cr, 25–30; Ni, 3–5; C, 0.10 max.; Mo, 1–1.5	Good	B, DD, F, R, W	B, CR, D, HR, I
18	**330 Stainless Steel, wrought**		Fe; Cr, 14–16; Ni, 33–36; C, 0.25		B, F, R	B, D, HR, P, S,
19	**347 Stainless Steel, wrought**		Fe; Cr, 17–20; Ni, 8–12; C, 0.10 max.; Cb8xC	Fair	B, DD, F, R, W	B, CR, D, HR, I
20	**403 Stainless Steel, wrought**		Fe; Cr, 11.5–13; C, 0.15 max.	Fair	DD, F, R, W	B, CR, D, HR, I
21	**405 Stainless Steel, wrought**		Fe; Cr, 11.5–13.5; C, 0.08; Al, 0.10–0.20			B, CR, D, HR, I
22	**406 Stainless Steel, wrought**		Fe; Cr, 12–14; C, 0.15 max.; Al, 4–4.5			B, CR, D, HR, I
23	**410 Stainless Steel, wrought**		Fe; Cr, 10–14; C, 0.15 max.	Fair	B, DD, F, R, W	B, CR, D, HR, I
24	**414 Stainless Steel, wrought**		Fe; Cr, 10–14; Ni, 2.5 max.; C, 0.15 max.		B, DD, F,W	B, D, HR, P, R,
25	**416 Stainless Steel, wrought**		Fe; Cr, 12–14; C, 0.15 max.; S or Se, 0.07 min. or Mo, 0.60 max.	Good	Welding, forging	B, CR, D, HR, P,
26	**418 Stainless Steel, wrought**		Fe; Cr, 12–14; C, 0.15 max.; W, 2.5–3.5			
27	**420 Stainless Steel, wrought**		Fe; Cr, 12–14; C, > 0.15	Fair	B, DD, F, R, W	B, CR, D, HR, I
28	**420F Stainless Steel, wrought**		Fe; Cr, 12–14; C, > 0.15; S or Se, 0.07 min. or Mo, 0.60 max.	Good	B, R, W	
29	**430 Stainless Steel, wrought**		Fe; Cr, 14–18; C, 0.12 max.	Fair	B, DD, F, R, W	B, CR, HR, P, R
30	**430F Stainless Steel, wrought**		Fe; Cr, 14–18; C, 0.12 max.; S or Se, 0.07 min. or Mo, 0.60 max.	Good	B, R, W	B, CR, D, HR, I
31	**431 Stainless Steel, wrought**		Fe; Cr, 14–18; Ni, 2.5 max.; C, 0.15 max.			B, CR, D, HR, I
32	**440 Stainless Steel, wrought**		Fe; Cr, 14–18; C, > 0.12	Fair	B, R, W	B, CR, D, HR, R
33	**441 Stainless Steel, wrought**		Fe; Cr, 14–18; Ni, 2.5 max.; C, > 0.15		B, W	B, CR, D, HR, P
34	**442 Stainless Steel, wrought**		Fe; Cr, 18–23; C, 0.35 max.	Fair	B, DD, F, R, W	B, CR, D, HR, P
35	**446 Stainless Steel, wrought**		Fe; Cr, 23–30; C, 0.35 max.	Fair	B, F, R, W	B, CR, D, HR, P
36	**501 Stainless Steel, wrought**		Fe; Cr, 4–6; C, > 0.10	Fair	DD, F, R, W	B, CR, D, HR, P
37	**502 Stainless Steel, wrought**		Fe; Cr, 4–6; C, 0.10 max.	Fair	DD, F, R, W	B, CR, D, HR, P
38	**CA-14 Stainless Steel, cast***	*See next page for manufacturer's name and address.	Fe; Cr, 11–14; Ni, 1 max.; C, 0.14 max.	Good		Castings
39	**CA-40 Stainless Steel, cast***		Fe; Cr, 11–14; Ni, 1 max.; C, 0.20–0.40	Good		Castings
40	**CB-30 Stainless Steel, cast***		Fe; Cr, 18–22; Ni, 2 max.; C, 0.30 max.			Castings
41	**CC-35 Stainless Steel, cast***		Fe; Cr, 27–30; Ni, 3 max.; C, 0.35 max.	Fair	F, W	Castings
42	**CD-10M Stainless Steel, cast***		Fe; Cr, 27–30; Ni, 3–6; C, 0.10 max.; Mo, 2.00 max.			Castings

[1] Stable solutions only. [2] Depending on service. [3] Composition given is for castings. [4] Higher carbon if specified. [5] With molybdenum. [6] Total immersion only.

Construction of Chemical Engin

Forms Available	Sulphuric Acid							Hydrochloric Acid						Nitric Acid						A	
	Temp.	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	20%	Conc.	Temp.	0.5%	5%	20%	65%		Temp	0.5%
B, CR, D, HR, P, S, W														Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, S, W, T, R														Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, S, W																					
B, CR, D, HR, P, S, W														Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, R, S, T, W	Room	R	R				R							Room Boiling	R R	R R	R R	R R		Room Boiling	R R [6]
B, CR, D, HR, P, R, S, T, W	Room	R	R				R							Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, R, S, W														Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, S, W	Room	R	R				R							Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, R, S, T, W	Room	R	R				R							Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, S, W	Room	R	R				R							Room Boiling	R R	R R	R R	R R		Room	R
B, D, P, S, W														Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R		R	R	R							Room Boiling	R R	R R	R R	R R		Room Boiling	R R
B, CR, HR, P, R, S, T, W	Room Boiling	R R	R		R	R	R							Room Boiling	R R	R R	R R	R R		Room Boiling	R R
B, CR, D, HR, P, R, S, T, W	Room	R	R				R							Room Boiling	R R	R R	R R	R R		Room Boiling	R R [6]
B, CR, D, HR, P, S, W	Room	R	R	R	R		R														
B, CR, D, HR, P, S, W														Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, S, W	Room Boiling	R R	R R		R		R							Room Boiling	R R	R R	R R	R R		Room Boiling	R R
B, D, HR, P, S, W	Primarily used for furnace parts and other high-temperature applications																				
B, CR, D, HR, P, R, S, T, W	Room	R	R				R							Room Boiling	R R	R R	R R	R R		Room Boiling	R R [6]
B, CR, D, HR, P, R, S, T, W																					
B, CR, D, HR, P, S, W																					
B, CR, D, HR, P, S, W																					
B, CR, D, HR, P, R, S, T, W																					
B, D, HR, P, R, S, W																					
B, CR, D, HR, P, R, S, T, W																					
B, CR, D, HR, P, R, S, W																					
B, CR, HR, P, R, S, T, W	Room						R							Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, R, W																					
B, CR, D, HR, P, S, W	Room						R							Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, R, S, W																					
B, CR, D, HR, P, R, S, W																					
B, CR, D, HR, P, R, S	Room						R							Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, R, S, T, W	Room						R							Room Boiling	R R	R R	R R	R R		Room	R
B, CR, D, HR, P, R, S, T, W																					
B, CR, D, HR, P, R, S, T, W																					
Castings	Principal uses are valves and fittings, and pumps in oil refineries													Room			R	R		Room	R
Castings	Principal uses are valves and fittings, and pumps in oil refineries													Room			R	R			
Castings														Room Boiling	R R	R R	R R	R R		Room Boiling	R R
Castings	Room	R												Room Boiling	R R	R R	R R	R R		Room Boiling	R R
Castings	Room Boiling	R R	R R				R	R						Room Boiling	R R	R R	R R	R R		Room Boiling	R R

rsion only.

al Engineering Equipment

Nitric Acid				Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
0.5%	5%	20%	65%	Temp	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
R R	R R	R R	R R	Room	R	R	R	R												Good	Good	1
R R	R R	R R	R R	Room	R	R	R	R												Good	Fair	2
																						3
R R	R R	R R	R R	Room	R	R														Good		4
R R	R R	R R	R R	Room Boiling	R R[6]	R R	R	R	Room	R	R	R	Room Boiling	R R	R R							5
R R	R R	R R	R R	Room	R	R	R	R	Room	R	R	R	Room Boiling	R R	R R		Room	R				6
R R	R R	R R	R R	Room	R	R	R	R	Room	R	R	R	Room	R	R		Room	R		Good	Good	7
R R	R R	R R	R R	Room	R	R	R	R														8
R R	R R	R R	R R	Room	R	R	R	R					Room Boiling	R R	R R	R R	Room	R		Good	Fair	9
R R	R R	R R	R R	Room	R	R	R	R	Room	R	R	R										10
R R	R R	R R	R R	Room	R	R																11
R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R		Room	R	R	Good	Good	12
R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R		Room	R	R	Good	Good	13
R R	R R	R R	R R	Room Boiling	R R[6]	R R	R	R	Room	R	R	R	Room Boiling			R R						14
																						15
R R	R R	R R	R R	Room	R	R	R	R	Room	R	R	R										16
R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling			R R						17
																				Good		18
R R	R R	R R	R R	Room Boiling	R R[6]	R R			Room	R	R	R	Room Boiling	R	R	R R				Good	Good	19
																						20
																						21
																						22
																				Fair	Fair	23
																				Fair	Poor	24
																				Fair	Fair	25
																						26
																				Fair	Fair	27
																						28
R R	R R	R R	R R	Room	R	R							Room Boiling			R R				Fair	Fair	29
																						30
R R	R R	R R	R R	Room	R	R																31
																				Fair	Good	32
																				Fair	Good	33
R R	R R	R R	R R	Room	R	R							Room Boiling			R R						34
R R	R R	R R	R R	Room	R	R			Room	R	R	R	Room Boiling			R R				Excel.	Good	35
																				Fair	Fair	36
																						37
		R	R	Room	R	R							Room	R						Fair	Fair	38
		R	R																	Fair	Fair	39
R R	R R	R R	R R	Room Boiling	R R	R R	R	R	Room Boiling	R R	R R	R R	Room	R	R	R	Short immersions at room temperature			Fair	Fair	40
R R	R R	R R	R R	Room Boiling	R R	R R	R	R	Room Boiling	R R	R	R	Room Boiling	R R	R	R	Short immersions at room temperature			Good	Fair	41
R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling			R R						42

Terms Use

Composition

"Essential nominal chemical composition" refers to the principal constituents and the approximate proportion present. When "[illegible] shown without percentage it is assumed that it represents the balance of the composition.

Forms Available

B = bars
C = castings
CR = cold rolled
D = drawn
HR = hot rolled
P = plates
R = rods
S = sheets
T = tubes
W = wire

Methods of Fabrication

B = brazing
DD = deep drawing
F = flanging
R = riveting
W = welding

Corrosion Data

R indicates that the metal or alloy should give reasonably good resistance under the conditions of concentration and temperature specified, but it does not imply any guarantee of satisfactory service. The figure following the R are the reported result of laboratory corrosion tests in inches penetration per year. Where a space is left blank either there is insufficient data available to indicate the extent of resistance or more complete information concerning the service required is necessary).

Footnotes

Superior numbers refer to footnotes

Continued

Metals and Alloys for Const

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities	Methods of Fabrication	Forms Available	Temp.
129	**Durimet T**	Duriron, Co., Dayton, O.	Fe; Cr, 19; Ni, 22; C, 0.07 max.; Mo, 3.5; Cu, 1	Fair	W	B, C, D, HR, P, R, S, W	Room Boiling
130	**Durimet 20**	Duriron Co., Dayton O.	Fe; Cr, 20; Ni, 29; C, .07 max.; Cu. 4; Si, 1; Mo, 3.5	Fair	W	Castings	Room 176° F. Boiling
131	**Duriron**	Duriron Co., Dayton, O.	Fe; C, 0.80; Si, 14.50; Mn, 0.35	Poor	W	Castings	Room Boiling
132	**Elverite A**	Babcock & Wilcox Co., New York, N. Y.	Fe; C, 3.00–3.5; Mn, 0.35; Si, 0.25–1.0				Used for its a
133	**Elverite B**	Babcock & Wilcox Co., New York, N. Y.	Fe; Cr, 1–1.8; Ni, 3.75–4.75; C, 3–3.5; Si, 0.25–1				Used for its a
134	**Elverite C**	Babcock & Wilcox Co., New York, N. Y.	Fe; Cr, 1–1.8; C, 3–3.5; Si, 0.25–1; Ni, 3.75–4.75				Used for its a
135	**Empire 8**	Empire Steel Castings, Reading, Pa.	Fe; Cr, 1–1.25; C, 0.30–0.35; Mo, 0.25–0.3; Mn; .6–.8	Fair	W	Castings	
136	**Empire 11**	Empire Steel Castings, Reading, Pa.	Fe; Cr, 1–1.25; Ni, 2.25–2.75; C, 0.25–0.3; Mo, .3–.35	Fair	W	Castings	
137	**Empire 12**	Empire Steel Castings, Reading, Pa.	Fe; Cr, 4.5–6.0; C, 0.20–0.30; Mn, 0.40—0.70	Fair	W	Castings	
138	**Empire 23**	Empire Steel Castings, Reading, Pa.	Fe; Cr, 13–17; Ni, 34–37; C, 0.15–0.25; Mn, 0.40–0.70	Fair	W	Castings	
139	**Genesee 255**	Symington-Gould Corp., Rochester, N. Y.	Fe; Cr, 5; C, 0.20; Mn, 0.70; Mo, 0.50	Fair			
140	**Genesee 4-12**	Symington-Gould Corp., Rochester, N. Y.	Fe; C, 1.10; Mn, 11–14	Poor		Castings	
141	**Ing Aclad Stainless Clad Steel 302**	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	Fe; Cr, 18–20; Ni, 8–10; C, 0.20 max.				
142	**Ing Aclad Stainless Clad Steel 304**	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	Fe; Cr, 18–20; Ni, 8–10; C, 0.20 max.	Fair	B, DD, F, R, W	HR, P, S	Room
143	**Ing Aclad Stainless Clad Steel 309**	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	Fe; Cr, 22–26; Ni, 12–14; C, 0.20 max.; Mn, 2 max.	Poor	B, DD, F, R, W	HR, P, S	Room
144	**Ing Aclad Stainless Clad Steel 316**	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	Fe; Cr, 16–18; Ni, 10–14; C, 0.10 max.; Mo, 2–3; Mn, 2 max.				
145	**Ing Aclad Stainless Clad Steel 317**	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	Fe; Cr, 18.20; Ni, 10–14; C, 0.10 max.; Mn, 2 max.; Mo, 3–4	Poor	F, DD, F, R, W	HR, P, S	Room
146	**Ing Aclad Stainless Clad Steel 321**	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	Fe; Cr, 17–20; Ni, 7–10; C, 0.10 max.; Ti, 10 x C; Mn, 2 max.				
147	**Ing Aclad Stainless Clad Steel 347**	Ingersoll Steel & Disc Div., Borg Warner Corp., Chicago, Ill.	Fe; Cr, 17–20; Ni, 8–12; C, 0.10 max.; Mn, 2 max.; Cb, 10 x C	Poor	B, DD, F, R, W	HR, P, S	Room
148	**K-4**	Key Co., E. St. Louis, Ill.	Fe; Cr, 4-6; C, .30 max.; Mo, .05			Castings	Fittings for g
149	**K-8**	Key Co., E. St. Louis, Ill.	Fe; Cr, 8–10; C, .16 max.; Mo, 1.5			Castings	Fittings for g
150	**K-9**	Key Co., E. St. Louis, Ill.	Fe; Cr, 2; C, .30 max.; Mo, .5			Castings	Fittings for g
151	**K-13**	Key Co., E. St. Louis, Ill.	Fe; Cr, 18; Ni, 8; C, .15 max.; Co			Castings	Fittings for g
152	**Kanthal A**	C. O. Jelliff Manufacturing Corp., Southport, Conn.	Fe; Cr, 20–25; Co, 1–3; Al, 6	Fair	B, R, W	R, W	These alloys a
153	**Kanthal D**	C. O. Jelliff Manufacturing Corp., Southport, Conn.	Fe; Cr, 20–25; Co, 1–3; Al, 4–5	Fair	B, R, W	R, W	These alloys a
154	**Manganese-Molybdenum Steel**	Lukens Steel Co., Coatesville, Pa.	Fe; C, 0.25 max.; Mn, 1.65 max.; Mo, 0.75 max.; Si, 0.25 max.	Fair	F, R, W	HR, P, S	
155	**Mayari R**	Bethlehem Steel Co., Bethlehem, Pa.	Fe; Cr, 0.2–1.0; Ni, 0.25–0.75; C, 0.12 max.; Cu, 0.5–0.7; Mn, 0.5–1	Good	B, F, R, W	B, CR, HR, P, R, S, T, W, shapes	About 6 times
156	**Midvaloy ATV 3**	Midvale Co., Nicetown, Philadephia, Pa.	Fe; Cr, 14; Ni, 26.5; C, 0.48; W. 3.5	Good		B, C, forgings	
157	**Milwaukee 28-12**	Milwaukee Steel Foundry, Milwaukee, Wis.	Fe; Cr, 27–30; Ni, 11–13; C, 0.25 max.	Poor	R, W	Castings	
158	**Milwaukee 15-26**	Milwaukee Steel Foundry, Milwaukee, Wis.	Fe; Cr, 14–17; Ni, 25–28; C, 0.45 max.	Fair	R, W	Castings	Primarily a he
159	**Milwaukee M 3**	Milwaukee Steel Foundry, Milwaukee, Wis.	Fe; Cr, 13–15; Ni, 0.50–1; C, 0.12–0.20	Good	R, W	Castings	Primarily for p
160	**Milwaukee M 4**	Milwaukee Steel Foundry, Milwaukee, Wis.	Fe; Cr, 13–15; Ni, 0.50–1; C, 0.12–0.20; Mo, 0.90–1	Good	R, W	Castings	Primarily for p
161	**Milwaukee K-G Wear Resistant**	Milwaukee Steel Foundry, Milwaukee, Wis.	Fe; Cr, 11–12; C, 1.45–1.60; Mo, 0.90–1; Va, 0.20–0.25	Poor	R	Castings	Primarily for a
162	**Milwaukee Si-Cu**	Milwaukee Steel Foundry, Milwaukee, Wis.	Fe; C, 0.25 max.; Si, 2–2.5; Cu, 1–1.25			Castings	
163	**Milwaukee 22 Cr-1.20 C**	Milwaukee Steel Foundry, Milwaukee, Wis.	Fe; Cr, 20–22; Ni, 0.25 max.; C, 1.25–1.50; Mo, 0.50–0.60; Si, 2.0–2.5	Poor	R	Castings	Primarily for a
164	**Miscrome 4**	Michigan Steel Casting Co., Detroit, Mich.	Fe; Cr, 11.5–13; C, 0.12 max.; Ni, 0.80 max.	Good		Castings	Principal uses
165	**Nichrome**	Driver Harris Co., Harrison, N. J.	Fe; Cr, 15; Ni, 60	Good	B, DD, F, R, W	B, CR, HR, P, R, S, T, W	Room Boiling
166	**2% Nickel Steel**	Lukens Steel Co., Coatesville, Pa.	Fe; Ni, 2.0 min.; C, 0.20 max.	Poor	F, R, W	HR, P, S	
167	**Ni-Hard**	International Nickel Co., New York, N. Y.	Fe; Cr, 1.4–1.6; Ni; 4.4–4.6; C, 2.75–3.6; Si, 0.5–1	Poor		Castings	
168	**Nilstain**	Wilber B. Driver Co., Newark, N. J.	Fe; Cr, 18–20; Ni, 8–10; C, >.20; Mn, 2 max.	Good	W	D, HR, R, W	
169	**Ni-Resist**	International Nickel Co., New York, N. Y.	Fe; Ni, 13–15; Cu, 5.5–7; C, 2.95–3.10; Cr, 1.5–2.5; Mn, 1–1.75	Good		Castings	Room Boiling
170	**Pyrasteel 20**	Chicago Steel Foundry Co., Chicago, Ill.	Fe; Cr, 16–18; Ni, 35				
171	**Pyrasteel 2000**	Chicago Steel Foundry Co., Chicago, Ill.	Fe; Cr, 26; Ni, 12–14				
172	**Pyrasteel 18**	Chicago Steel Foundry Co., Chicago, Ill.	Fe; Cr, 16; Ni, 25				
173	**Pyrasteel 14**	Chicago Steel Foundry Co., Chicago, Ill.	Fe; Cr, 6; Mo, 0.40–0.60				

[1] Stable solutions only.

ys for Construction of Chemical Engineering

	Forms Available	Sulphuric Acid							Hydrochloric Acid						Nitric Acid					A	
		Temp.	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	20%	Conc.	Temp.	0.5%	5%	20%	65%	Temp.	0.5%
	B, C, D, HR, P, R, S, W	Room Boiling	R R	R R	R R	R	R	R R	Room	R	R	R	R	R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	Castings	Room 170° F. Boiling	R R R	R R R	R R R	R R R	R R R	R R	Room	R	R	R	R	R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	Castings	Room Boiling	R R	R R	R R	R R	R R	R R	Room	R	R	.003	.006	.010	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
		Used for its abrasion resistance for pulverizers (Coal, cement, etc.)																			
		Used for its abrasion resistance for pulverizers (Coal, cement, etc.)																			
		Used for its abrasion resistance for pulverizers (Coal, cement, etc.)																			
	Castings																				
	Castings																				
	Castings																				
	Castings																				
	Castings																				
W	HR, P, S	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
W	HR, P, S	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
W	HR, P, S	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
W	HR, P, S	Room	R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	Castings	Fittings for general corrosion and heat resisting service in oil refinery																			
	Castings	Fittings for general corrosion and heat resisting service in oil refinery																			
	Castings	Fittings for general corrosion and heat resisting service in oil refinery																			
	Castings	Fittings for general corrosion and heat resisting service in oil refinery																			
	R, W	These alloys are primarily used for heat resistant parts, particularly in sulphurous atmospheres and electrical heating elements at extreme temperatures up to 2,400 °F.																			
	R, W	These alloys are primarily used for heat resistant parts, particularly in sulphurous atmospheres and electrical heating elements at extreme temperatures up to 2,400 °F.																			
	HR, P, S																				
	B, CR, HR, P, R, S, T, W, shapes	About 6 times greater resistance to atmospheric corrosion than plain carbon steel																			
	B, C, forgings																				
	Castings														Room Boiling	R R	R R	R R	R R	Room	R
	Castings	Primarily a heat resisting alloy																			
	Castings	Primarily for paper mill equipment where good resistance to sulphite, sulphate liquors is desired																			
	Castings	Primarily for paper mill equipment where good resistance to sulphite, sulphate liquors is desired																			
	Castings	Primarily for abrasion resistance where extreme wearing qualities are desired																			
	Castings																				
	Castings	Primarily for abrasion resistance																			
	Castings	Principal uses are valves and fittings, and pumps in oil refineries													Room			R	R		
W	B, CR, HR, P, R, S, T, W	Room Boiling	R R	R R	R	R	R	R	Room Boiling	R R	R R	R	R	R	Room Boiling	R R	R R	R	R	Room Boiling	R R
	HR, P, S																				
	Castings																				
	D, HR, R, W								Room					R	Room Boiling	R R	R R	R R	R	Room Boiling	R R
	Castings	Room Boiling	R R		R.0344	R.0310			Room	R	R	R.0117	R.012							Room Boiling	R R

ring Equipment

Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
Temp.	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
Room Boiling	R R	R R	R R	R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room	R[1]	R[1]	Good	Fair	129
Room Boiling	R R	R R	R R	R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room	R	R	Good	Fair	130
Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R	R	Room	R	R	Good	Good	131
																	Good	132
																	Good	133
																	Good	134
																	Good	135
																	Good	136
																	Fair	137
																	Poor	138
																		139
																	Good	140
																		141
Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R					Good	Fair	142
Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R						Good		143
																		144
Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R						Good		145
																		146
Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R						Good		147
																		148
																		149
																		150
																		151
p to 2,400 °F.																Good		152
p to 2,400 °F.																Good		153
																Fair		154
																Fair	Fair	155
																Good	Fair	156
Room	R	R	R	R														157
																Good		158
																		159
																		160
																	Good	161
																		162
																	Good	163
																Fair		164
Room Boiling	R R	R R	R R	R R					Room Boiling	R R	R R	R R				Good	Poor	165
																Fair		166
																Good		167
Room Boiling	R R	R R	R R	R R	Room	R			Room	R	R	R				Good		168
Room Boiling	R R	R R	0208		Room	R	R	R	Room Boiling	R R	R R	R R						169
																		170
																		171
																		172
																		173

Terms Used

Composition
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Forms Available
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Methods of Fabrication
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Corrosion Data
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Footnotes
Superior numbers refer to footnotes.

Continued

Metals and Alloys f

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities	Methods of Fabrication	
84	**Abrasion Resisting**	Lukens Steel Co., Coatesville, Pa.	Fe; C, 0.4–0.5; Mn, 1.80 max.	Fair	R	HR, P
85	**Alchrome 3**	Wilbur B. Driver Co., Newark, N. J.	Fe; Cr, 20; Al, 3	Fair		R, W
86	**Alchrome 6**	Wilbur B. Driver Co., Newark, N. J.	Fe; Cr, 20; Al, 6	Fair		R, W
87	**Allegheny Metal 20-25S**	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 19–21; Ni, 24–26; C, 0.11 max.		R, W	Castings
88	**Allegheny Metal 20-25 SM**	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 19–21; Ni, 24–26; C, 0.11 max.; Mo, 2–3		R, W	Castings
89	**Allegheny Metal 12 Chr.**	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	Fe; Cr, 10–13.5; Ni, 1 max.; C, 0.15		R, W	Castings
90	**Allegheny Puramelt**	Allegheny Ludlum Steel Corp., Pittsburgh, Pa.	(See footnote 13)			
91	**Alray D**	Alloy Metal Wire Co., Prospect Park, Pa.	Fe; Cr, 35; Ni, 15		B, R, W	
92	**Amsco Hardface-Self Hardening**	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; C; Cr; Mo; Mn	Poor	W	
93	**Amsco Hard Facing Rod 217**	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; C; Cr; Mh; W; Mo	Poor		Welding r
94	**Amsco Hard Facing Welding Rod 459**	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; C; Cr; Mn; Mo	Poor		Welding r
95	**Amsco Manganese Steel**	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago Heights, Ill.	Fe; C, 1.05–1.20; Mn, 12.5–13; Si, 0.4–0.6		R, W	
96	**Amsco Ni-Mn Welding Rod**	Amer. Manganese Steel Div., Amer. Brake Shoe & Fdry. Co., Chicago, Heights, Ill.	Fe; C, 0.75–0.95; Mn, 13–15; Ni; 3.5–4.5			Welding w
97	**B & W 5150**	Babcock & Wilcox Co., New York, N. Y.	Fe; Cr, 1.4; C, 1.0; Mn, 0.4; Si, 0.25			
98	**Bethlehem 235**	Bethlehem Steel Co., Bethlehem, Pa.	Fe; C, 0.35–0.50; Mn, 1.20–1.75; Si, 0.15–0.25	Fair		
99	**Buffokast Gray Iron**	Buffalo Fdry. & Machine Co., Buffalo, N. Y.	Fe; C, 3.2–3.6; Ni, 2 max.; Si, 1–2; Mn, 0.6–0.9	Good		Castings
100	**Carbon-Molybdenum Steel**	Lukens Steel Co., Coatesville, Pa.	Fe; C, 0.18–0.28; Mo, 0.4–0.6; Mn, 0.5–0.9	Good	F, R, W	HR, P, S
101	**Caussl Metal**	Lunkenheimer Co., Cincinnati, O.	Fe; Ni, 18–22; C, 2.2–2.8; Cu, 3.5–5.5; Cr, 1.4–1.9; Mn, 0.9–1.5			Castings
102	**Chromax**	Driver Harris Co., Harrison, N. J.	Fe; Cr, 19; Ni, 35	Good	B, DD, F, R, W	B, CR, H
103	**Chromel C**	Hoskins Mfg. Co., Detroit, Mich.	Fe; Cr, 16; Ni, 61; C, 0.10	Good	B, F, R, W	B, CR, D
104	**4-6 Chrome**	Spang Chalfant Division, Pittsburgh, Pa.	Fe; Cr, 4–6; C, 0.10 max.; Mn, 0.5 max.; Ti, 4–6 x C	Good	F, W	HR, T
105	**4-6 Chrome**	Spang Chalfant Division, Pittsburgh, Pa.	Fe; Cr, 4–6; C, 0.20 max.; Mn, 0.5 max.	Good	F, W	HR, T
106	**Chrome-Copper-Nickel Steel**	Lukens Steel Co., Coatesville, Pa.	Fe; Cr, 0.65–0.85; Ni, 0.75 max.; C, 0.12 max.; Cu, 0.45–0.65	Fair	F, R, W	HR, P, S
107	**Chrome-Manganese Steel**	Lukens Steel Co., Coatesville, Pa.	Fe; Cr, 0.50; Mn, 0.90; C, 0.40	Fair	F, R, W	HR, P, S
108	**Circle L1**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; C, 0.30; Mn, 1.35; Va., 0.10	Good	W	Castings
109	**Circle L2**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 0.75; C, 0.30; Mn, 1.35; Mo, 0.35	Fair	W	Castings
110	**Circle L3**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 1.0; C, 0.45; Mo, 0.40	Fair	W	Castings
111	**Circle L 5**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 0.8; C, 0.30; Ni, 2; Mo, 0.35	Fair	W	Castings
112	**Circle L 10**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 4–6; C, 0.20; Mo, 0.50	Good	W	Castings
113	**Circle L 19**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Ni, 2.75; C, 0.18	Good	W	Castings
114	**Circle L 34**	Lebanon Steel Fdry., Lebanon, Pa.	Fe; Cr, 20; Ni, 30; C, 0.07 max.; Mo, 3; Cu, 5	Fair	W	Castings
115	**Colonial 610**	Vanadium-Alloys Steel Co., Latrobe, Pa.	Fe; Cr, 16–18; Ni, 1; C, 0.12 max.; S, optional; Mn, .25-4.	Fair	W, B	B, D, HR
116	**Cooper 21 A-B-C**	Cooper Alloy Fdry. Co., Elizabeth, N. J.	Fe; Cr, 15–20; Ni, 20–25; C, 0.07–0.10; Mo, 3; Si, 1.5	Good		Castings
117	**Cooper 22-P-M**	Cooper Alloy Fdry. Co., Elizabeth, N. J.	Fe; Cr, 29; Ni, 9; C, 0.2–0.5; Mo, 3	Good	F, R, W	Castings
118	**Corrosiron**	Pacific Foundry Co., San Francisco, Calif.	Fe; C, 0.8–1.0; Si, 14.50; Mn, 0.50	Fair		Castings
119	**Crane 5-Cr-Mo Cast Steel**	Crane Co., Chicago, Ill.	Fe; Cr, 4–6; C, 0.30 max.; Mo, 0.55	Fair	W	Castings
120	**Croloy 2**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 2; C, 0.15 max.; Mo, 0.50	Fair	DD, F, R, W	B, C, HR
121	**Croloy 2¼**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 2.25; C, .15 max.; Mo, 1	Fair	DD, F, R, W	B, C, HR
122	**Croloy 5**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 4–6; C, 0.15 max.; Mo, 0.45–0.65	Fair	DD, F, R, W	B, C, HR
123	**Croloy 7**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 7; C, .15 max.; Mo, .55; Si, .50–1	Fair	DD, F, R, W	B, C, HR
124	**Croloy 9**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 8–10; C, 0.15 max.; Mo, 1.2–1.5	Fair	DD, F, R, W	B, C, P, S
125	**Croloy 16-13-3**	Babcock & Wilcox Tube Co., Beaver Falls, Pa.	Fe; Cr, 17; Ni, 13; C, 0.10 max.; Mo, 2.75	Fair	DD, F, R, W	B, C, CR
126	**Duploy 30**	Sowers Manufacturing Co., Buffalo, N. Y.	Fe; Cr, 2.35; Ni, 18.50; C, 2.85; Mn, 1	Good		Castings
127	**Duraloy 25-20 Mo**	Duraloy Co., Scottdale, Pa.	Fe; Cr, 24–26; Ni, 19–21; C, 0.20; Mo, 2–3	Fair		Castings
128	**Durichlor**	Duriron Co., Dayton, Pa.	Fe; C, 0.85; Si, 14.5; Mo, 3; Mn, 0.35	Poor	W	Castings

[13] **Allegheny Puramelt (clad) stainless steels are available in many of the standard compositions.**

ys for Construction of Chemical Engineering I

	Forms Available	Sulphuric Acid							Hydrochloric Acid						Nitric Acid					Acet	
		Temp	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	28%	Conc.	Temp.	0.5%	5%	20%	65%	Temp.	0.5%
	HR, P																				
	R, W	Primarily used for electric heat resisting application																			
	R, W	Primarily used for electric heat resisting application																			
	Castings																				
	Castings																				
	Castings																				
		Room Boiling	R R		R				Room Boiling	R R		R R			Room Boiling	R R		R R	R R	R R	Room Boiling	R R
		Can be welded to carbon steel and forged — Resists extreme shock and abrasion																			
	Welding rod	For resisting extreme abrasion at temperatures up to 1000 deg. F. not recommended where extreme shock or impact is involved																			
	Welding rod	Hard facing for all wearing parts not subjected to temperatures over 800 deg. F.																			
	Welding wire																				
	Castings																				
	HR, P, S																				
	Castings	Room 150 F.			R R	R R		R R													
R, W	B, CR, HR, P, R, S, W	Room Boiling	R R	R R	R	R	R	R	Room Boiling	R R	R R	R R	R	R	Room Boiling	R R	R R	R	R	Room Boiling	R R
	B, CR, D, HR, R, W	Primarily for heat resistant parts and heating elements																			
	HR, T																				
	HR, T																				
	HR, P, S	Primarily for impact resistance at sub-zero temperatures																			
	HR, P, S																				
	Castings	Used for high-pressure valve bodies																			
	Castings	Applications include crank shafts, connecting rods																			
	Castings	Good abrasion resistance makes it satisfactory for crusher segments, and similar uses																			
	Castings	Used for pumps and fittings for high-pressure hot oil in refinery service																			
	Castings	Oil still parts and high pressure steam fittings																			
	Castings	Applications include low-temperature dewaxing pumps and fittings																			
	Castings	Boiling				R .036			Room Boiling					R .0084 (50%)	Boiling				R .0086		
	B, D, HR, P, R, S, W														Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	Castings	An alloy primarily used for hot sulphuric acid							Satisfactory for certain applications handling hydrochloric acid												
	Castings	The sulphite pulp industry uses this alloy for digester fittings, pumps, valve fittings, and piping																			
	Castings	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R			Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	Castings	Valves, fittings and piping for general corrosion and heat resistance																			
W	B, C, HR, P, S, T, W	Low cost alloy steel having good creep strength. Principal use tubes in petroleum refineries																			
W	B, C, HR, P, S, T	High creep strength, low alloy steel. Principal use in tubes for petroleum refineries and for superheating steam																			
W	B, C, HR, D, P, S, R, T, W	Nominal cost intermediate alloy for elevated temperature applications. Used principally for tubes for oil cracking, and for steam superheaters.																			
W	B, C, HR, P, S, T	Alloy steel for petroleum refinery application, having excellent resistance to hot oil corrosion																			
W	B, C, P, S, R, T, W	Semi stainless alloy specifically developed for oil — cracking and hydrogenation																			
W	B, C, CR, HR, P, S, R, T, W	This alloy is used for sulphite liquors and catalytic oil cracking													Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	Castings	Room Boiling	.012 .022						Room Boiling	.105 .142										Room Boiling	.0019 .0033
	Castings	Room Boiling	R R	R				R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	Castings	Room Boiling	R R	R R	R R	R R	R R	R R	Room	R	R	R	R	R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R

Caution! In t

Laboratory tests made with che under carefully controlled condit approach actual operating conditio the laboratory data reported here to be used only as an indication service tests or trial installations case should they be used to calcul or to estimate the life of equipment

gineering Equipment

Nitric Acid				Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
0.5%	5%	20%	65%	Temp.	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
																				Fair	Good	84
																						85
																						86
																						87
																						88
																						89
																						90
R	R	R	R	Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R		Good		91
R	R	R	R	Boiling	R	R	R	R	Boiling	R	R	R	Boiling	R	R	R						
																				Fair	Good	92
et is involved																				Good	Good	93
																				Fair	Good	94
																				Poor	Good	95
																				Poor	Good	96
																					Good	97
																					Good	98
																					Good	99
																				Good		100
													212F.	R	R	R						101
R	R	R	R	Room	R	R	R	R					Room	R	R	R				Good	Poor	102
R	R			Boiling	R	R	R	R					Boiling	R	R	R						
																				Good		103
																					Fair	104
																					Fair	105
																				Fair		106
																				Fair		107
																					Fair	108
																					Good	109
																					Good	110
																					Fair	111
																				Fair	Fair	112
																					Fair	113
			R .0086						Boiling			R.037								Poor	Fair	114
R	R	R	R	Room	R	R	R						Room	R	R		Room	R		Good	Poor	115
R	R	R	R	Boiling	R	R							Boiling	R	R		Boiling	R				
																				Poor	Fair	116
																				Good	Fair	117
R	R	R	R	Room	R	R	R	R	Room	R	R	R	Room	R	R		Room	R		Fair	Good	118
R	R	R	R	Boiling	R	R	R	R	Boiling	R	R	R	Boiling	R								
																				Fair	Fair	119
																				Fair	Fair	120
																				Fair	Fair	121
l for steam superheaters.																				Fair	Fair	122
																				Fair	Fair	123
																				Fair	Fair	124
R	R	R	R	Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Short immersions at room temperature				Fair	125
				Boiling	R	R	R	R	Boiling	R	R		Boiling	R								
				Room	.0019								Room	.0305						Good		126
				Boiling	.0033								Boiling	.0306								
R	R	R	R	Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R		Good		127
R	R	R	R	Boiling	R	R	R	R														
R	R	R	R	Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R	R	Fair	Good	128
R	R	R	R	Boiling	R	R	R	R	Boiling	R	R	R	Boiling	R			Boiling	R	R			

Caution! In the Use of Laboratory Corrosion Data!

Laboratory tests made with chemically pure reagents under carefully controlled conditions seldom if ever approach actual operating conditions of service. At best the laboratory data reported here by manufacturers are to be used only as an indication as to whether or not service tests or trial installations are advisable. In no case should they be used to calculate a depreciation rate or to estimate the life of equipment.

In writing to manufacturers for supplementary information in regard to specific problems *Chem. & Met.* urgently recommends the submission of the very fullest information in regard to the actual conditions encountered in the plant. Failure to report a minor constituent such as the presence of an impurity or amount of aeration, agitation, concentration and temperature, may result in the selection of an improper material with needless loss to the user—THE EDITOR.

Terms Used

Composition
"Essential nominal chemical composition" refers to the principal constituents and the approximate proportion present. When "Fe" is shown without percentage it may be assumed that it represents the balance of the composition.

Forms Available
B = bars
C = castings
CR = cold rolled
D = drawn
HR = hot rolled
P = plates
R = rods
S = sheets
T = tubes
W = wire

Methods of Fabrication
B = brazing
DD = deep drawing
F = flanging
R = riveting
W = welding

Corrosion Data
R indicates that the metal or alloy should give reasonably good resistance under the conditions of concentration and temperature specified, but it does not imply any guarantee of satisfactory service. The figures following the R are the reported result of laboratory corrosion test in inches penetration per year. Where space is left blank either there are insufficient data available to indicate the extent of resistance or more complete information concerning the service required is necessary.

Footnotes
Superior numbers refer to footnotes.

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities	Methods of Fabrication	Forms Available	Temp.	
174	**Pyrocast**	Pacific Fdry. Co., San Francisco, Calif.	Fe; Cr, 29–30; C, 1.75–2.0	Good		Castings	Room Boiling	
175	**0-4**	Otis Elevator Co., Buffalo, N. Y.	Fe; Cr, 4–8; C, 0.15–0.35; Mo, 0.25–2; Mn, 0.45–0.85	Good				Use
176	**0-16**	Otis Elevator Co., Buffalo, N. Y.	Fe; Cr, 14–18; C, 0.12 max.; Mn, 0.5 max.	Good				
177	**Sivyer 5% Cr**	Sivyer Steel Castings Co., Milwaukee, Wis.	Fe; Cr, 4.5–6.5; C, 0.25 max.; Mo, 0.45–0.65	Good		Castings		
178	**Spang Chalfant 1**	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; C, 0.15; Cr, 1.75–2.25; Mn, 0.3–0.6; Mo, 0.45–0.65	Good	F, W	HR, T		
179	**Spang Chalfant 2**	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; C, 0.1–0.2; Mn, 0.3–0.6; Si, 0.25 max.	Good	F, W	HR		
180	**Spang Chalfant 3**	Spang Chalfant Div., Nat. Supply Co., Pittsburgh, Pa.	Fe; C, 0.1–0.2; Mo, 0.45–0.65; Mn, 0.3–0.6; Si, 0.25 max.	Good	F, W	HR		
181	**Timken 16-13-3**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 15.5–17; Ni, 12.5–14.5; C, 0.13 max.; Mo, 2.5–3.25; Mn, 1.5 max.	Fair	DD, F, R, W	B, D, HR, R, T, W		Use
182	**Timken 2512**	Timken Roller Bearing Co., Canton, Ohio	Fe; Ni, 4.75–5.25; C, 0.20 max.	Good		T		App
183	**Timken 2% Cr-0.5% Mo**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 1.75–2.25; C, 0.15 max.; Mo, 0.45–0.65; Mn, 0.30–0.60	Good	F, W	B, HR, T		Pet
184	**Timken 5 Cr-Mo plus Ti**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 4.6; C, 0.12 max.; Mn, 0.50 max.; Mo, 0.45–0.65; Ti, 4 x C min., 0.70 max.	Good	F, W	B, HR, R, T		For
185	**Timken DM**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 1–1.5; C, 0.15 max.; Mn, 0.3–0.6; Mo, 0.45–0.65	Good	F, W	B, HR, R, T		Pet
186	**Timken Sicromo 5S**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 4–6; C, 0.15 max.; Si, 1–2; Mn, 0.5 max.; Mo, 0.45–0.65	Fair	F, W	B, HR, R, T		For
187	**Timken Sicromo 7**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 6–8; C, 0.15 max.; Si, 0.5–1; Mn, 0.50 max.; Mo, 0.45–0.65	Good	DD, F, R, W	B, D, HR, R, T, W		An
188	**Timken Sicromo 7M**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 6–8; C, 0.15 max.; Mo, 0.9–1.1; Mn, 0.50 max.; Si 0.5–1	Good	DD, F, R, W	B, D, HR, R, T, W		For
189	**Timken Sicromo 9M**	Timken Roller Bearing Co., Canton, Ohio	Fe; Cr, 8–10; C, 0.15 max.; Mn, 0.50 max.; Mo, 0.9–1.1	Good	DD, F, R, W	B, D, HR, R, T, W		Hig
190	**Tisco 41**	Taylor Wharton Iron & Steel Co., High Bridge, N. J.	Fe; C, 0.5; Cr, 1; Mn, 0.7		W	Castings		
191	**Tisco 53**	Taylor Wharton Iron & Steel Co., High Bridge, N. J.	Fe; Cr, 5; C, 0.25; Mn, 0.60; Mo, 0.50	Good	W	Castings		
192	**Tisco 80**	Taylor Wharton Iron & Steel Co., High Bridge, N. J.	Fe; Ni, 2; Cr, 1.5; C, 0.45; Mn, 0.7; Mo, 0.35	Fair		Castings		
193	**Tisco 150**	Taylor Wharton Iron & Steel Co., High Bridge, N. J.	Fe; Cr, 28–32; Ni, 1–1.5; C, 2.5–3			Castings		
194	**Tophet C**	Wilber B. Driver Co., Newark, N. J.	Fe; Ni, 60; Cr, 15			D, HR, R, W	Room	
195	**Tophet D**	Wilber B. Driver Co., Newark, N. J.	Fe; Ni, 35; Cr, 18.5	Good		B, CR, D, HR, RW		Prim
196	**Utiloy 46**	Utility Electric Steel Foundry, Los Angeles, Cal.	Fe; Cr, 4–7; C, 0.25 max.; Mo. 0.50; Mn .75; Si, 0.40	Good	W	Castings		Refi
197	**Utiloy 12**	Utility Electric Steel Foundry, Los Angeles, Cal.	Fe; Cr, 11–13; C, 0.12 max.; Mn, 0.40; Si, 0.90	Good	W	Castings		Hot
198	**Utiloy 12N**	Utility Electric Steel Foundry, Los Angeles, Cal.	Fe; Cr, 11–13; C, 0.12 max.; Ni, 1.75–2.50	Good	W	Castings		Val
199	**Utiloy X**	Utility Electric Steel Foundry, Los Angeles, Cal.	Fe; Cr, 18; Ni, 8; C, 0.15 max.; Si, 0.90; Mn. 0.50	Good	W	Castings		
200	**Utiloy XX**	Utility Electric Steel Foundry, Los Angeles, Cal.	Fe; Cr, 18; Ni, 8; C, 0.07 max.; Mo, 3.5–4.5	Fair	W	Castings	Room	
201	**Utiloy H**	Utility Electric Steel Foundry, Los Angeles, Cal.	Fe; Cr, 23–26; Ni, 11–13; C, 0.28–0.32; Si, 0.90–1.10; Mn, 0.60–0.80; N, 0.12	Fair	W	Castings		Hea
202	**Warman 5M**	Warman Steel Casting Co., Los Angles, Calif.	Fe; Cr, 5–7; C as specified; Mo, 0.50–0.60	Good	W	Castings		
203	**Worthite**	Worthington Pump & Machinery Corp., Harrison, N. J.	Fe; Cr, 20; Ni, 24; Cu, 1.75; C, 0.07; Si, 3.25; Mo, 3.0; Mn, 0.60	Good	W	B, C, HR, R	Room 176 F.	
204	**Wrought Iron, Genuine**	A. M. Byers Company, Pittsburgh, Pa.	Fe; C, 0.02; Mn, 0.03; P, 0.12; S, 0.02; Si, 0.15	Good	F, R, W	B, HR, P, R, S, T		Rea ov
	NON-FERROUS ALLOYS							
205	**Admiralty**	Generally available [11]	Cu, 70; Sn, 1; Zn, 29	Fair	B, DD, F, R, W	CR, D, P, S, T	Room Boiling	
206	**Adnic**	Scovill Mfg. Co., Waterbury, Conn.	Cu, 70; Ni, 29; Sn, 1	Fair	B, DD, F, R, W	CR, D, R, T, W		
207	**Advance**	Driver Harris Co., Harrison, N. J.	Cu, 55; Ni, 45	Good	B, DD, F, R, W	B, CR, HR, P, R, S, W		Thin
208	**Alcoa 2S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al, 99 min.	Good	B, DD, F, R, W	B, CR, CR, D, HR, P, R, S, T, W	Room	R
209	**Alcoa 3S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mn, 1.2	Good	B, DD, F, R, W	B, CR, D, HR, P, R, S, T, W	Room	
210	**Alcoa 52S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Cr, 0.25; Mg, 2.5	Good	B, DD, F, R, W	B, CR, D, HR, P, R, S, T, W	Room	
211	**Alcoa 53S**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 1.3; Si, 0.7; Cr, 0.25	Good	B, DD, F, R, W	B, CR, D, HR, P, R, S, T, W	Room	
212	**Alcoa Alclad (72 S) 3 S**	Aluminum Co. of Amer., Pittsburgh, Pa.	(See Footnote 8)	Good	DD, F, R, W	D, P, S, T		Appl sol
213	**Alcoa 43**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Si, 5	Fair	B, R, W	Castings		Used

[7] In cast form known as Alcoa 100. [8] Surface layer of aluminum alloy which is anodic to the core and will therefore protect the latter electrolytically. [9] Aerated. [10] No measurable penetra
Bridgeport, Conn.; Bristol Brass Corp., Bristol, Conn.; Chase Brass & Copper Co., Waterbury, Conn.; Mueller Brass Co., Huron, Mich.; New England Brass Co., Taunton, Mass.; Phelps Dod

ys for Construction of Chemical Engineering E

	Forms Available	Sulphuric Acid							Hydrochloric Acid						Nitric Acid					Acetic				
		Temp.	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	20%	Conc.	Temp.	0.5%	5%	20%	65%	Temp.	0.5%	1
	Castings	Room Boiling	R				R R	R R							Room Boiling	R R	R R		R R	Room Boiling	R R	
		Used in petroleum refineries and in conditions involving pressures and temperatures up to 1,200 deg. F.																				
															Room				R	Room Boiling	R R	
	Castings																					
	HR, T																					
	HR																					
	HR																					
W	B, D, HR, R, T, W	Used primarily for its high-temperature strength and corrosion resistance up to 1500 deg. F.																				
	T	Applications include tubes in black liquor evaporators for sulphate pulp industry																				
	B, HR, T	Petroleum refineries use this alloy steel for tubes, etc.																				
	B, HR, R, T	For petroleum refinery and steam superheater tubes																				
	B, HR, R, T	Petroleum refinery applications, and high-temperature steam																				
	B, HR, R, T	For air preheater tubes, petroleum refinery applications, superheaters, and furnace parts																				
W	B, D, HR, R, T, W	An intermediate alloy steel at low cost																				
W	B, D, HR, R, T, W	For applications at elevated temperatures where good load carrying ability and corrosion resistance are desired. In petroleum refineries																				
W	B, D, HR, R, T, W	High temperature strength with corrosion resistance for oil refining up to 1,400 deg. F.																				
	Castings																					
	Castings																					
	Castings																					
	Castings																					
	D, HR, R, W	Room						R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R	
	B, CR, D, HR, RW	Primarily used for heat resisting parts and heating elements																				
	Castings	Refinery valves, fittings, oil still parts — temperatures not over 1,100 °F.																				
	Castings	Hot oil pumps, valves and valve trim																				
	Castings	Valve trim — abrasive resistant																				
	Castings														Room Boiling	R R	R R	R R	R R	Room Boiling	R R	
	Castings	Room	R	R	R	R	R	R	Room	R	R				Room Boiling	R R	R R	R R	R R	Room Boiling	R R	
	Castings	Heat resisting for oil still supports — High creep strength																				
	Castings																					
	B, C, HR, R	Room 176 F.	R <.0001 R .0001	R <.0001 R .010	R .0002 R .026	R .0003 R .024	R .0006	R .0007 R .048	Room 176 F.	R .0015	R .010	R .028	R .029		Room 176 F.	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R .004	Room 176 F.	R <.0001 R <.0001	< <
	B, HR, P, R, S, T	Reasonably good resistance to 77.6% acid and over up to boiling point																				
, W	CR, D, P, S, T	Room Boiling	R R	R R	R R	R	R	R	Room Boiling	R R	R R	R R	R							Room Boiling	R R	
W	CR, D, R, T, W																					
W	B, CR, HR, P, R, S, W	This alloy used primarily for thermocouple wire, electrical resistance																				
W	B, C[7], CR, D, HR, P, R, S, T, W	Room	R.006	R.01	R.016	R.025	.2	.1							Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.					Room 122 F.	R.001 01	
W	B, CR, D, HR, P, R, S, T, W	Room			.03										Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.					Room		
W	B, CR, D, HR, P, R, S, T, W	Room			.03										Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.					Room		
W	B, CR, D, HR, P, R, S, T, W	Room			.028				Room	.001	.03	1	30		Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.					Room		
	D, P, S, T	Applications include equipment or parts used in contact with neutral corrosive solutions where resistance to perforation by corrosion is desired													Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.							
	Castings	Used for castings of moderate strength and moderate resistance to corrosion													Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.							

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Corros tion per results were c specifie standar compare on this whether case sh wise es Complet a decis facturer

lly. [9] Aerated. [10] No measurable penetration. [11] Coin (Ag, 90; Cu, 10), sterling (Ag, 92.5; Cu, 7.5), and clad are also available. [12] Copper and copper alloys
nd Brass Co., Taunton, Mass.; Phelps Dodge Copper Products Corp., New York, N. Y.; Revere Copper & Brass, Inc., New York, N. Y.; Riverside Metal Co., Rivers

ng Equipment

Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
n ng	R R	R R	R R	R R	Room		R	R	Room	R	R	R				Good	Good	174
																Good	Fair	175
n ng	R R	R R	R R	R R	Room	R			Room	R	R	R				Good	Poor	176
																	Good	177
																	Fair	178
																	Fair	179
																	Fair	180
																Good	Poor	181
																		182
																Fair		183
																		184
																Fair		185
																Good		186
																Good		187
																Good		188
																Good		189
																		190
																		191
																	Good	192
																	Good	193
n ng	R R	R R	R R	R R	Room	R			Room Boiling	R R	R R	R R				Good		194
																Good		195
																Fair	Good	196
																Fair	Fair	197
																Fair	Good	198
m ing	R R	R R	R R	R R	Room Boiling	R R	R R		Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Fair	Poor	199
m ing	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Fair	Fair	200
																Good	Poor	201
																	Good	202
m F.	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.0001	Room 176 F.	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R	Room 176 F.	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.0001	Room	R		Good	Good	203
									Room Boiling	R R	R R	R R				Good	Good	204
m ing	R R	R R	R	R	Room Boiling	R R	R	R	Room Boiling	R R	R	R					Fair	205
																	Good	206
																Good	Poor	207
m F.	R.001 01	R.001 .009	R.001 .005	R.0004 R.003					Room	.09						Good	Fair	208
m		R.001		R					Room	.08						Good	Fair	209
m		R.001							Room	.15						Good	Fair	210
m		R.001							Room	.17						Good	Fair	211
																Good	Fair	212
																Good	Fair	213

Acknowledgment of Source

At the repeated demand of its readers for concrete information on the resistance to corrosion, heat and abrasion of the various materials available for the construction of chemical engineering equipment, *Chem. & Met.* has, with the cooperation of manufacturers, compiled this tabulation of the properties of the metals and alloys.

All information on mechanical, physical and chemical properties as well as indication of reasonably good resistance to corrosion are made on the authority of the manufacturers to whom questionnaires were submitted.

Corrosion Data—The generally accepted unit of "inches penetration per year" has been used by the manufacturers in reporting results of corrosion tests. Conditions of temperature and concentration were outlined in the questionnaire and except where otherwise specified, it is understood the tests were not aerated. But since no standard test procedure is universally used the data are not always comparable. Therefore, as indicated in the note of caution elsewhere on this chart, the laboratory results should be used only to indicate whether or not service tests or trial installations are advisable. In no case should they be used to calculate a depreciation rate or otherwise estimate the exact life of a metal or alloy in actual service. Complete information regarding methods of testing and the bases for a decision of suitability can usually be obtained from the manufacturer on request.

Terms Used

Composition
"Essential nominal chemical composition" refers to the principal constituents and the approximate proportion present. When "Fe" is shown without percentage it may be assumed that it represents the balance of the composition.

Forms Available
B = bars
C = castings
CR = cold rolled
D = drawn
HR = hot rolled
P = plates
R = rods
S = sheets
T = tubes
W = wire

Methods of Fabrication
B = brazing
DD = deep drawing
F = flanging
R = riveting
W = welding

Corrosion Data
R indicates that the metal or alloy should give reasonably good resistance under the conditions of concentration and temperature specified, but it does not imply any guarantee of satisfactory service. The figures following the R are the reported result of laboratory corrosion test in inches penetration per year. Where space is left blank either there are insufficient data available to indicate the extent of resistance or more complete information concerning the service required is necessary.

Footnotes
Superior numbers refer to footnotes.

opper alloys are available from such companies as the following: American Brass Co., Waterbury, Conn.; Bridgeport Brass Co., al Co., Riverside N. J.; Scovill Mfg. Co., Waterbury, Conn.; Seymour Mfg. Co., Seymour, Conn.; Wolverine Tube Co., Detroit, Mich.

Continued

Metals and Alloys fo

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities	Methods of Fabrication	
214	**Alcoa B214**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 3.8; Si, 1.8	Good	R, W	Castings
215	**Alcoa 220-T 4**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mg, 10	Good	R, W	Castings
216	**Alcoa 356**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Si, 7; Mg, 0.3	Fair	B, R, W	Castings
217	**Alcoa 406**	Aluminum Co. of Amer., Pittsburgh, Pa.	Al; Mn, 2	Good	B, R, W	Castings
218	**Alcumite**	Duriron Co., Dayton, Ohio	Cu, 89.75; Al, 9.0; Fe, 1.25	Good	B, W	Castings
219	**Alloy A**	C. O. Jelliff Mfg. Corp., Southport, Conn.	Ni, 78–80; Cr, 20 max.; Si, 1.5 max.	Good	B, DD, F, R, W	CR, D,
220	**Alloy C**	C. O. Jelliff Mfg. Corp., Southport, Conn.	Ni, 58–62; Cr, 14–18; Si, 1.5 max.	Good	B, DD, F, R, W	CR, D,
221	**Alloy D**	C. O. Jelliff Mfg. Corp., Southport, Conn.	Ni, 30–35; Cr, 15–20; Si, 1.5 max.	Good	B, F, R, W	CR, D,
222	**Alloy 45**	C. O. Jelliff Mfg. Corp., Southport, Conn.	Ni, 45; Cu, 55	Good		D, HR,
223	**Alray A**	Alloy Metal Wire Co., Prospect Park, Pa.	Ni, 80; Cr, 20	Poor		Wire, R
224	**Aluminum Bronze**	American Brass Co., Waterbury, Conn.	Cu, 82–95; Al, 5–9.5; Fe; Mn; Ni; Sn	Fair	B, DD, F, R	C, CR,
225	**Aluminum Bronze**	Hills McKanna Co., Chicago, Ill.	Cu, 85–89; Al, 9–10; Fe, 1–4; Mn, 0.5	Good		Castings
226	**Aluminum Bronze 5%**	Revere Copper & Brass, New York, N. Y.	Cu, 95; Al, 5	Fair		T
227	**Aluminum Brass**	Generally available [12]	Cu, 76; Zn, 21.5–22; Al, 2–2.5	Fair	B, DD, F, R	CR, D,
228	**Ambrac 850**	American Brass Co., Waterbury, Conn.	Cu, 75; Ni, 20; Zn, 5	Fair	DD, F, R, W, B	B, C, C
229	**Ampco 16**	Ampco Metal, Milwaukee, Wis.	Cu; Al, 9.3–10.3; Fe, 3.0–3.75			
230	**Ampco 18**	Ampco Metal, Milwaukee, Wis.	Cu, 84.6; Al, 11.3; Fe, 3.7; Ni, 0.2	Good	B, R, W	B, C
231	**Ampco 20**	Ampco Metal, Milwaukee, Wis.	Cu; Al, 11.4–12.2; Fe, 3.5–4.3			
232	**Ampcoloy**	Ampco Metal, Milwaukee, Wis.	Cu; Al, 10–11; Fe, 1.25 max.	Good	B, R, W	Castings
233	**Antimonial Admiralty**	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 72; Zn, 27; Sb, 0.07; Sn, 1	Fair		S, T, W
234	**Arsenical Admiralty**	American Brass Co., Waterbury, Conn.	Cu, 70; Zn, 28.95; Sn, 1; As, 0.05		B, F, W	T
235	**Arsenical Copper**	Generally Available [12]	Cu; As, 0.15–0.75	Fair	B, F, R, W	D, T
236	**Beralcy**	Wilbur B. Driver Co., Newark, N. J.	Cu; Be, 1.9; Co, 0.5	Good		B, CR,
237	**Beralcy 175**	Wilbur B. Driver Co., Newark, N. J.	Cu; Be, 1.9; Ni, 0.5 max.	Good		B, CR,
238	**Beryllium Copper**	American Brass Co., Waterbury, Conn.	Cu, 97.40; Be, 2.25; Ni, 0.35	Fair	DD, F	B, C, C
239	**Beryllium Copper**	Riverside Metal Co., Riverside, N. J.	Cu, 97.65; Be, 2.00; Ni, 0.35	Fair	B, DD, F, R, W	B, CR,
240	**Cadmium-Copper**	Phelps Dodge Copper Prod. Corp., New York	Cu, 99; Cd, 1		B, DD, F	B, CR,
241	**Chromel A**	Hoskins Mfg. Co., Detroit, Mich.	Ni, 78; Cr, 20; Mn, 2 max., C, 0.06	Good	B, F, R, W	B, CR,
242	**Colmonoy 6**	Wall-Colmonoy Corp., Detroit, Mich.	Ni, 63–73; Cr, 15–22; B, 3–5	Poor	B, W	B, C, R
243	**Chromium Copper**	American Brass Co., Waterbury, Conn.	Cu, 99.05; Cr, 0.85; Si, 0.10	Fair	DD, F	B, C, C
244	**Commercial Bronze F. C.**	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 89; Zn, 9; Pb, 2	Good		R
245	**Cupron**	Wilbur B. Driver Co., Newark, N. J.	Cu; Ni, 45	Good	Wire	B, CR,
246	**20% Cupro-Nickel**	Generally available [12]	Cu, 80; Ni, 20	Fair	B, DD, F, R, W	P, T
247	**30% Cupro-Nickel**	Generally available [12]	Cu, 70; Ni, 30	Fair	B, DD, F, R, W	B, C, C
248	**Dioxidized Copper**	Generally available [12]	Cu, 99.9+; P, 0.01–0.03	Tough	B, DD, F, R, W	B, C, C
249	**Dowmetal C**	Dow Chemical Co., Midland, Mich.	Mg; Al, 9.0; Mn, 0.1; Zn, 2.0	Excellent	R, W	Castings
250	**Dowmetal J**	Dow Chemical Co., Midland, Mich.	Mg; Al, 6.5; Mn, 0.2; Zn, 1.0	Excellent	DD, R, W	B, CR,
251	**Dowmetal M**	Dow Chemical Co., Midland, Mich.	Mg; Mn, 1.5	Excellent	DD, F, R, W	B, C, C
252	**Dowmetal O**	Dow Chemical Co., Midland, Mich.	Mg; Al, 8.5; Mn, 0.2; Zn, 0.5	Excellent	R, W	B, R, T
253	**Durco D-10**	Duriron Co., Dayton, Ohio	Ni, 57; Cr, 23; Cu, 8; Mo, 4; W, 2; Mn, 1	Fair		Castings
254	**Everdur 1000**	American Brass Co., Waterbury, Conn.	Cu, 94.9; Si, 4; Mn, 1.1	Fair	B, W	Castings

[12] Copper and copper alloys are available from such companies as the following: American Brass Co., Waterbury, Conn.; Bridgeport Brass Co., Bridgeport, C N. Y.; Riverside Metal Co., Riverside, N. J.; Scovill Mfg. Co., Waterbury, Conn.; Seymour Mfg. Co., Seymour, Conn.; Wolverine Tube Co., Detroit, Mich.

ys for Construction of Chemical Engineering E

ds tion	Forms Available	Sulphuric Acid							Hydrochloric Acid						Nitric Acid					Acet	
		Temp.	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	20%	Conc.	Temp.	0.5%	5%	20%	65%	Temp.	0.5%
	Castings	Castings of moderate strength and good resistance to corrosion by neutral or slightly alkaline solutions												Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.							
	Castings	Cast parts and fittings of high strength and good resistance to neutral or slightly alkaline solutions												Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.							
	Castings	Castings of moderate strength and moderate resistance to corrosion												Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.							
	Castings	Fittings and parts of moderate strength and good resistance to neutral or acid solutions												Average penetration of aluminum alloys in 95% acid at room temperature is .001 in. per yr.							
	Castings	Room	R	R	R	R			Room	R	R									Room	R
R, W	CR, D, HR, R, W	Room Boiling	R R	R R	R	R	R	R	Room Boiling	R R	R R	R	R		Room Boiling	R R	R R	R	R		Room Boiling	R R
R, W	CR, D, HR, R, W	Room Boiling	R R	R R	R	R	R	R	Room Boiling	R R	R	R	R		Room Boiling	R R	R R	R	R		Room Boiling	R R
W	CR, D, HR, R, W	Room Boiling	R R	R R	R	R	R	R	Room Boiling	R R	R	R	R		Room Boiling	R R	R R	R	R		Room Boiling	R R
	D, HR, R, W	This alloy is primarily used for thermocouple wire, electrical resistance																			
	Wire, Rod & Strip	Room Boiling	R R	R	R				Room Boiling	R R	R R	R	R	R	Room Boiling	R R	R R	R	R		Room Boiling	R R
, R	C, CR, F, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
	Castings	Room Boiling	R R	R R	R	R														Room Boiling	R R
	T	Used almost exclusively for heat exchanger applications utilizing high velocity corrosive cooling waters																			
, R	CR, D, T	Used primarily for condenser and heat exchanger tubes																			
, W, B	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
		Generally satisfactory for handling of sulphuric, hydrochloric, acetic and phosphoric acids, also resists sodium hydroxide under certain conditions																			
	B, C	Generally satisfactory for handling of sulphuric, hydrochloric, acetic and phosphoric acids, also resists sodium hydroxide under certain conditions																			
		Generally satisfactory for handling of sulphuric, hydrochloric, acetic and phosphoric acids, also resists sodium hydroxide under certain conditions																			
	Castings	Generally satisfactory for handling of sulphuric, acetic and phosphoric acids, also resists sodium hydroxide under certain conditions																			
	S, T, W	Room Boiling	R R	R					Room Boiling	R R	R				Room	R				Room Boiling	R R
	T	Used principally for heat exchanger tubes in oil refineries																			
W	D, T	Principal applications include condenser and heat exchanger tubes																			
	B, CR, D, HR	Primarily used for springs, diaphragms, switch parts, welding parts																			
	B, CR, D, HR	Primarily used for springs, diaphragms, switch parts, welding parts																			
	B, C, CR, D, HR, P, R, S, W	Used for springs, diaphragms, switch parts, tools, welding apparatus, gears, pinions, etc., where high strength and corrosion resistance are desired																			
, R, W	B, CR, D, P, R, S, W	Used primarily for its non-sparking characteristic for contact springs, diaphragms, switch parts welding apparatus, gears, pinions																			
	B, CR, D, HR, R, W																				
W	B, CR, D, HR, R, W	Primarily used for heat resisting parts and heating elements																			
	B, C, R	A coating for shaft sleeves, plungers, seal rings, gudgeons, cams, valves, lifters, etc. Balls and seats, mixers, screws, filter bars																			
	B, C, CR, D, HR, P, R, S, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
	R	Room Boiling	R R	R R					Room	R	R				Room	R				Room Boiling	R R
	B, CR, D, HR	Primarily used for thermocouple wire and electrical resistances																			
, R, W	P, T	Primarily used for condenser and heat exchanger tubes, and condenser plates																			
, R, W	B, C, CR, D, HR, P, R, S, T, W	Primarily used for condenser and heat exchanger tubes, and condenser plates																			
, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
	Castings	Suited for equipment to handle chromic acid and its salts, and hydrofluoric acid and salts																			
W	B, CR, HR, P, R, S, T	Suited for equipment to handle chromic acid and its salts, and hydrofluoric acids and salts																			
, W	B, C, CR, HR, P, R, S, T	Suited for equipment to handle chromic acid and its salts, and hydrofluoric acid and salts																			
	B, R, T	Suited for equipment to handle chromic acid and its salts, and hydrofluoric acid and salts																			
	Castings	Room Boiling	R R	R R	R R	R R	R	R R							Room Boiling	R R	R R	R R	R R		
	Castings	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R

Bridgeport, Conn.; Bristol Brass Corp., Bristol, Conn.; Chase Brass & Copper Co., Waterbury, Conn.; Mueller Brass Co., Huron, Mich.; New England Brass Co.,
roit, Mich.

gineering Equipment

Nitric Acid				Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
0.5%	5%	20%	65%	Temp.	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
on of aluminum alloys in 95% temperature is .001 in. per yr.																				Good	Fair	214
on of aluminum alloys in 95% temperature is .001 in. per yr.																				Good	Fair	215
on of aluminum alloys in 95% temperature is .001 in. per yr.																				Good	Fair	216
on of aluminum alloys in 95% temperature is .001 in. per yr.																				Good	Fair	217
				Room	R								Room	R						Good	Fair	218
R	R	R	R	Room	R	R	R	R	Room	R			Room	R	R	R	Room	R	R	Good	Fair	219
R	R	R		Boiling	R	R	R	R					Boiling	R	R	R						
R	R	R	R	Room	R	R	R	R	Room	R			Room	R	R	R	Room	R	R	Good	Fair	220
R	R	R		Boiling	R	R	R	R					Boiling	R	R	R						
R	R	R	R	Room	R	R	R	R	Room	R	R		Room	R	R	R	Room	R		Good		221
R	R			Boiling	R	R	R	R	Boiling	R			Boiling	R	R	R						
																				Good	Poor	222
R	R	R	R	Room	R	R	R	R	Room	R	R	R	Room	R	R	R				Exc.	Good	223
R	R	R	R	Boiling	R	R	R	R	Boiling	R	R	R	Boiling	R	R	R						
				Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R		Good	Fair	224
				Boiling	R	R	R	R	Boiling	R	R		Boiling	R								
				Room	R	R			Room	R										Good	Fair	225
				Boiling	R																	
																					Fair	226
																					Fair	227
				Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R	R	Fair	Fair	228
				Boiling	R	R	R	R	Boiling	R	R	R	Boiling	R	R	R	Boiling	R				
hydroxide under																						229
n hydroxide under																				Good	Good	230
m hydroxide under																						231
r certain conditions																				Good	Good	232
	R			Room	R	R							Room	R	R	R	Room	R		Fair		233
				Boiling	R	R							Boiling	R	R	R	Boiling	R				
																						234
																					Poor	235
																						236
																						237
th and corrosion resistance are																				Good	Good	238
atus, gears, pinions																				Good		239
																						240
																				Good		241
screws, filter bars																				Good	Good	242
				Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R			Good	243
				Boiling	R	R	R	R	Boiling	R			Boiling	R								
	R			Room	R	R	R	R					Room	R	R	R	Room	R				244
				Boiling	R	R							Boiling	R	R	R	Boiling	R				
																						245
																				Fair		246
																				Fair	Fair	247
				Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R			Fair	248
				Boiling	R	R	R	R	Boiling	R			Boiling	R								
													Room	R	R	R				Good	Fair	249
													Boiling	R								
													Room	R	R	R				Good	Fair	250
													Boiling	R								
													Room	R	R	R				Good	Fair	251
													Boiling	R								
													Room	R	R	R				Good	Fair	252
													Boiling	R								
R	R	R	R																		Fair	253
R	R	R	R																			
				Room	R	R	R	R	Room	R	R	R	Room	R	R	R	Room	R			Fair	254
				Boiling	R	R	R	R	Boiling	R			Boiling	R								

., Huron, Mich.; New England Brass Co., Taunton, Mass.; Phelps Dodge Copper Products Corp., New York, N. Y.; Revere Copper & Brass, Inc., New York,

Terms Used

Composition

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Corrosion Data

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Footnotes

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No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities	Methods of Fabrication	Forms Available	Temp.	0.
255	**Everdur 1010**	American Brass Co., Waterbury, Conn.	Cu, 95.8; Si, 3.1; Mn, 1.1		B, DD, F, R, W	B, CR, D, HR, P, R, S, T, W	Room Boiling	
256	**Everdur 1015**	American Brass Co., Waterbury, Conn.	Cu, 98.25; Si, 1.5; Mn, 0.25	Fair	B, DD, F, R, W	B, CR, D, HR, P, R, S, T, W	Room Boiling	
257	**Frontier 5**	Frontier Bronze Corp., Niagara Falls, N. Y.	Cu, 89; Al, 10; Fe, 1	Tough		Castings	Room Boiling	
258	**Frontier 11**	Frontier Bronze Corp., Niagara Falls, N. Y.	Cu, 88; Ni, 5; Sn, 5; Zn, 2	Good		Castings		
259	**Frontier 40**	Frontier Bronze Corp., Niagara Falls, N. Y.	Cu; Zn, 5; Mg, 0.5; Cr, 0.5; Ti, 0.2	Excellent		Castings		
260	**Gold**	Baker & Co., Newark, N. J.	Au, 99.99	Poor	B, DD, F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	
261	**Hastelloy A**	Haynes Stellite Co., Kokomo, Ind.	Ni; Mo; Fe	Good	DD, F, W	B, C, HR, P, R, S, T, W	Room Boiling	
262	**Hastelloy B**	Haynes Stellite Co., Kokomo, Ind.	Ni; Mo; Fe	Fair	DD, F, W	B, C, HR, P, R, S, T, W	Room Boiling	
263	**Hastelloy C**	Haynes Stellite Co., Kokomo, Ind.	Ni; Mo; Fe; Cr	Fair	DD, F, W	B, C, P, S, T	Room Boiling	
264	**Hastelloy D**	Haynes Stellite Co., Kokomo, Ind.	Ni; Si; Cu	Poor	W	B, C	Room Boiling	
265	**Hardware Bronze**	Scovill Mfg. Co., Waterbury, Conn.	Cu, 89; Zn, 8; Pb, 2; Ni, 1	Good	B, R	D, R, W		
266	**Herculoy A**	Revere Copper & Brass, New York, N. Y.	Cu, 96; Si, 3; Mn, 1; Sn, 0.5	Fair	B, DD, F, R, W	B, CR, D, HR, P, R, S, W	Room Boiling	
267	**Herculoy B**	Revere Copper & Brass, New York, N. Y.	Cu, 98; Si, 1.75; Sn, 0.25	Fair	B, W	B, CR, D, HR, P, R, S, T, W	Room	
268	**High Brass**	Generally available [12]	Cu, 66; Zn, 34					
269	**High Silicon Bronze**	Phelps Dodge Copper Prod., Corp., New York, N. Y.	Cu, 97.3; Sn, 1.65; Si, 1.05	Fair	B, DD, F	B, CR, D, HR, R, W		
270	**Illium G**	Burgess-Parr Co., Freeport, Ill.	Ni, 55–60; Cr, 18–24; Cu, 5–8; Mo, 5–8; Fe, 5–8; Mn, 1.5; Si; C	Fair	W	B, C, T	Room Boiling	
271	**Illium R**	Burgess-Parr Co., Freeport, Ill.	Ni, 55–60; Cr, 18–24; Mo, 5–8; Fe, 5–8; Cu, 2–6; Mn, 0.5–1.75; Si; C	Good	DD, R, W	B, C, CR, P, R, S, T, W	Room Boiling	
272	**Inconel**	International Nickel Co., New York, N. Y.	Ni, 79.5; Cr, 13; Fe, 6.5; Mn, 0.25; Si, 0.25; C, 0.08; Cu, 0.20	Fair	B, DD, F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	
273	**Inconel Clad Steel**	Lukens Steel Co., Coatesville, Pa.	Ni, 79.5; Cr, 13; Fe, 6.5; Mn, 0.25; Si, 0.25; C, 0.08; Cu, 0.20	Fair	F, R, W	HR, P, S	Room Boiling	
274	**Indium Metal**	American Smelting & Refining Co., New York, N. Y.	In	Poor	DD, F, W	B, C, CR, R, S, T, W		Used
275	**Iridio Platinum**	Baker & Co., Newark, N. J.	Pt; Ir, 5–30	Good	B, DD, F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	
276	**10% Iridium Platinum**	J. Bishop & Co., Malvern, Pa.	Pt, 90; Ir, 10	Fair	B, DD, F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	
277	**30% Iridium Platinum**	J. Bishop & Co., Malvern, Pa.	Pt, 70; Ir, 30	Good	B, DD, F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	
278	**Lead, Antimonial**	Amer. Smelting & Ref. Co., New York, N. Y. National Lead Co., New York, N. Y.	Pb, 94; Sb, 6	Good	DD, F, W	C, CR, D, R, S, T, W	Room Boiling	
279	**Lead, Antimonial**	Northwest Lead Co., Seattle, Wash.	Pb, 93.02–93.06; Sb, 6; Cu, 0.04–0.08	Good	F, W	B, C, S, T, W	Room Boiling	
280	**Lead, Asarco Acid**	Amer. Smelting & Ref. Co., New York, N. Y.	Pb; Cu, 0.06; Bi, 0.02	Fair	DD, F, W	C, CR, R, S, T, W	Room Boiling	
281	**Lead, Chemical**	Amer. Smelting & Ref. Co., New York, N. Y. National Lead Co., New York, N. Y.	Pb, 99.93; Cu, 0.06	Good	DD, F, W	B, C, CR, R, S, T, W	Room Boiling	
282	**Lead, Chemical**	Northwest Lead Co., Seattle, Wash.	Pb, 99.92–99.96; Cu, 0.04–0.08	Good	F, W	B, C, S, T, W	Room Boiling	
283	**Lead, Tellurium**	Amer. Smelting & Ref. Co., New York, N. Y. National Lead Co., New York, N. Y.	Pb, 99.88, Cu, 0.06; Te, 0.045	Good	DD, F, W	B, C, CR, R, S, T, W	Room Boiling	
284	**Lead, Tellurium**	Northwest Lead Co., Seattle, Wash.	Pb, 99.88; Cu, 0.06; Te, 0.045	Good	DD, F, W	B, C, CR, R, S, T, W	Room Boiling	
285	**Molybdenum**	P. R. Mallory & Co., Indianapolis, Ind.	Mo, 99.8–99.9	Poor	B	R, S, W		Pri
286	**Monel**	International Nickel Co., New York, N. Y.....	Ni, 67; Cu, 30; Fe, 1.4; Mn, 1; C, 0.15; Si, 0.1	Fair	B, DD, F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	
287	**Monel Clad Steel**	Lukens Steel Co., Coatesville, Pa.	Ni, 67; Cu, 30; Fe, 1.4; Mn, 1; C, 0.15; Si, 0.1	Fair	F, R, W	HR, P, S	Room Boiling	

[9] Aerated. [10] No measurable penetration. [11] Coin (Ag, 90; Cu, 10), sterling (Ag, 92.5; Cu, 7.5), and clad are also available. [12] Copper and copper alloys are available from such companie
Co., Taunton, Mass.; Phelps Dodge Copper Products Corp., New York, N. Y.; Revere Copper & Brass, Inc., New York, N. Y.; Riverside Metal Co., Riverside, N. J.; Scovill Mfg. Co., Water

...oys for Construction of Chemical Engineering ...

...ds ...ation	Forms Available	Sulphuric Acid						Hydrochloric Acid						Nitric Acid					Ac...	
		Temp.	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	20%	Conc.	Temp.	0.5%	5%	20%	65%	Temp.	0.5%
..., R, W	B, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
..., R, W	B, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
	Castings	Room Boiling	R R	R R	R R	R R	R R	R R												Room Boiling	R R
	Castings																				
	Castings																				
..., R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
...y	B, C, HR, P, R, S, T, W	Room Boiling	R R	R R	R .0027 R .036	R .0015 R .048	R 0004	R .0002	Room	R	R .036 [9]	R .024 [9]	R .007	R .004 [9]						Room Boiling	R R
...y	B, C, HR, P, R, S, T, W	Room Boiling	R R	R R	R .0018 R .0024	R .0012 R .0018	R .0004 R .034	R .0001 R .46	Room Boiling	R R	R .0036 [9] R .0096	R .0084 [9] R .0012	R .0036 [9] R .021	R .002 [9] R .017						Room Boiling	R R
...y	B, C, P, S, T	Room Boiling	R R	R R	R [10] R .050	R .0001 R .047	R	R [10] .312	Room Boiling	R	R .0002 [9]	R .0072 [9]	R .014 [9]	R .018 [9]	Room Boiling	R R	R R	R .18	R .0048	Room Boiling	R [10] R [10]
	B, C	Room Boiling	R R	R R	R .0024 R .013	R .0012 R .0089	R .0001 R .031	R .0001 0.42	Room Boiling	R R	R .024 [9] R .0096	R .024 [9]	R .030 [9]	R .013						Room Boiling	R R
	D, R, W																				
..., R, W	B, CR, D, HR, P, R, S, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R	R						Room Boiling	R R
	B, CR, D, HR, P, R, S, T, W	Room	R	R	R	R	R	R	Room	R	R	R	R	R						Room	R
									Room	R										Room Boiling	R R
	B, CR, D, HR, R, W																				
	B, C, T	Room Boiling	R R <.004	R [10] R <.004	R [10] R <.015	R [10] R .015	R .0065	R [10]	Room	R	R	R <.004			Room Boiling	R R	R R <.004	R R <.004	R <.001 <.004 0.065	Room Boiling	R R
...y	B, C, CR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room	R	R	R			Room Boiling	R R	R R	R R	R 0.065	Room Boiling	R R
..., R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R <.005 R <.005	R <.005 R .01-.03	R <.010 0.24	R <.010 0.64	R .046	0.271 0.43	Room Boiling	R <.005 R <.005	R <.01				Room Boiling	R <.01 R <.030	R .02-.08	R <.005	R <.005	Room Boiling	R <.005 R <.001
	HR, P, S	Room Boiling	R <.005 R <.005	R <.005 R .01-.03	R <.010 0.24	R <.010 0.64	R .046	0.271 0.43	Room Boiling	R <.005 R <.005	R <.01				Room Boiling	R <.01 R <.030	R .02-.08	R <.005	R <.005	Room Boiling	R <.005 R <.001
	B, C, CR, R, S, T, W	Used for bearings in order to prevent oil corrosion																		Room	R
..., R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
..., R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
..., R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	C, CR, D, R, S, T, W	Room Boiling	R R	R R	R.0007 R	R R	R	R.0012	Room 212° F.	R R	R.0012 R.0012	R.0012 R.007								Room	R
	B, C, S, T, W	Room Boiling	R R	R R	R R	R	R	R	Room Boiling	R R	R R	R R	R R	R R						Room	R
	C, CR, R, S, T, W	Room Boiling	R.0002 R.0005	R.0005 R.001	R.001 R.002	R.001 R.002	R.001 R.003	R.001 R													
	B, C, CR, R, S, T, W	Room Boiling	R R	R.002 R	R R	R R	R R	R	Room 212° F.	R.006 R.006	R.012 R.036	R.012 R.036								Room	R.020
	B, C, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R	Room Boiling	R R	R R	R								Room	R
	B, C, CR, R, S, T, W	Room Boiling	R R	R.002 R	R R	R R	R R	R	Room 212° F.	R.006 R.006	R.012 R.036	R.012 R.036								Room	R.020
	B, C, CR, R, S, T, W	Room Boiling	R R	R.002 R	R R	R R	R R	R	Room 212° F.	R.006 R.006	R.012 R.036	R.012 R.036								Room	R.020
	R, S, W	Primarily used for furnace elements and mercury switch electrodes																			
..., R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R <.010 R <.010	R <.010 R .003-.03	R <.010 R .002-.2	R <.005	R <.005	.080	Room Boiling	R <.005 R <.020	R <.005 R <.035	R <.010 .130	R <.030	R <.045	Room Boiling	R <.010 .025				Room Boiling	R <.005 R <.005
	HR, P, S	Room Boiling	R <.010 R <.010	R <.010 R .003-.03	R <.010 R .002-.2	R <.005	R <.005	.080	Room Boiling	R <.005 R <.020	R <.005 R <.035	R <.010 .130	R <.030	R <.045	Room Boiling	R <.010 .025				Room Boiling	R <.005 R <.005

...er alloys are available from such companies as the following: American Brass Co., Waterbury, Conn.; Bridgeport Brass Co., Bridgeport, Conn.; Bristol Brass Co..., Riverside, N. J.; Scovill Mfg. Co., Waterbury, Conn.; Seymour Mfg. Co., Seymour, Conn.; Wolverine Tube Co., Detroit, Mich.

ng Equipment

Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
emp.	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R	R	Room Boiling	R R	R	R	Room	R			Fair	255
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R	R	Room Boiling	R R	R	R	Room	R			Fair	256
oom oiling	R R	R R	R R	R R												Good	Good	257
																Good	Good	258
																	Good	259
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Good	Poor	260
oom oiling	R R	R .002 R .002	R R	R .0004 R .0084	Room Boiling	R .0021 R .026	R .0009 R .032	R .0003 R .816	Room Boiling	R R	R R	R R				Good	Fair	261
oom oiling	R R	R R	R R	R R	Room Boiling	R .0015 R .0018	R .0007 R .0017	R .0002 R .0015	Room Boiling	R R	R R	R R				Good	Fair	262
oom oiling	R[10] R[10]	R[10] R[10]	R[10] R[10]	R[10] R[10]	Room Boiling	R .0001 R .0014	R[10] R .003	R .0001 0.48	Room Boiling	R R	R R	R R	Room Boiling	R	R	Good	Fair	263
oom oiling	R R	R .0036 R .0045	R R	R .0005 R .0004	Room Boiling	R .0014 R .0028	R .0004 R .050	R .0003 .326	Room Boiling	R R	R R	R R				Fair	Good	264
																	Poor	265
oom oiling	R R	R R	R R	R R					Room	R							Fair	266
oom	R	R	R	R					Room	R							Fair	267
oom oiling	R R								Room Boiling	R R						Fair		268
																		269
oom oiling	R R	R[10] R	R R	R R	Room Boiling	R <.004 R <.004	R R <.015	R R	Room Boiling	R R <.001	R R <.001	R R <.001				Good	Good	270
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R <.001	R R <.001	R R <.001				Good	Good	271
oom oiling	R <.005 R <.001	R <.005 R <.015	R <.01 R <.015	R <.005 R <.010	Room	R <.005	R <.005	R <.01	Room Boiling	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.005				Good	Good	272
oom oiling	R <.005 R <.001	R <.005 R <.015	R <.01 R <.015	R <.005 R <.010	Room	R <.005	R <.005	R <.01	Room Boiling	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.005				Good	Good	273
oom	R	R	R	R												Poor	Poor	274
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Good	Good	275
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room	R	R	Good		276
oom oiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Good	Good	277
oom	R	R	R		Room 212° F.	R R	R R		Room	R						Fair	Poor	278
oom	R	R			Room Boiling	R R	R R		Room Boiling	R R	R R	R R				Poor	Poor	279
					Room Boiling	R.001 R.001	R.001 R.002	R.002 R.004									Poor	280
oom	R.020	R.018			Room 212° F.	R R	R R		Room	R						Fair	Poor	281
oom	R	R			Room Boiling	R R	R R		Room	R						Poor	Poor	282
oom	R.020	R.018			Room 212° F.	R R	R R		Room	R						Fair	Poor	283
oom	R.020	R.018			Room 212° F.	R R	R R		Room	R						Fair	Poor	284
																Good	Fair	285
oom oiling	R <.005 R <.005	R <.005 R <.005	R <.005 R <.005	R <.005 R <.010	Room Boiling	R <.005 R	R <.005 R	R <.005 R	Room Boiling	R <.0001 R <.0001	R <.0001 R <.001	R <.0001 R <.005				Good	Good	286
oom oiling	R <.005 R <.005	R <.005 R <.005	R <.005 R <.005	R <.005 R <.010	Room Boiling	R <.005 R	R <.005 R	R <.005 R	Room Boiling	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.005				Good	Good	287

stol Brass Corp., Bristol, Conn.; Chase Brass & Copper Co., Waterbury, Conn.; Mueller Brass Co., Huron, Mich.; New England Brass

Terms Used

Composition
"Essential nominal chemical composition" refers to the principal constituents and the approximate proportion present. When "Fe" is shown without percentage it may be assumed that it represents the balance of the composition.

Forms Available
B = bars
C = castings
CR = cold rolled
D = drawn
HR = hot rolled
P = plates
R = rods
S = sheets
T = tubes
W = wire

Methods of Fabrication
B = brazing
DD = deep drawing
F = flanging
R = riveting
W = welding

Corrosion Data
R indicates that the metal or alloy should give reasonably good resistance under the conditions of concentration and temperature specified, but it does not imply any guarantee of satisfactory service. The figures following the R are the reported result of laboratory corrosion test in inches penetration per year. Where space is left blank either there are insufficient data available to indicate the extent of resistance or more complete information concerning the service required is necessary.

Footnotes
Superior numbers refer to footnotes.

Continued

Metals and Alloys

No.	Material	Manufacturer	Essential Nominal Chemical Composition, Percent	Machining Qualities	Methods of Fabrication	
288	Muntz	Generally available [12]	Cu, 60; Zn, 40	Good	B, DD, F	R, S,
289	National Alloy 40	National Smelting Co., Cleveland, Ohio	Al; Cu, 4	Good		Castin
290	National Alloy 40 M	National Smelting Co., Cleveland, Ohio	Al; Mg, 4	Fair		Castin
291	National Alloy 42	National Smelting Co., Cleveland, Ohio	Al; Cu, 4.0; Si, 2.0			
292	National Alloy 70 S	National Smelting Co., Cleveland, Ohio	Al; Si, 7.5	Fair		Castin
293	National Alloy 5 Si	National Smelting Co., Cleveland, Ohio	Al; Si, 5.0			
294	National Alloy Red X 10	National Smelting Co., Cleveland, Ohio	Al; Si, 10; Cu, 1.5; Mn, 0.6; Mg, 0.5	Good		Castin
295	National Alloy Y	National Smelting Co., Cleveland, Ohio	Al; Cu, 4; Ni, 1.5; Mg, 1.5	Good		Castin
296	National Aluminum 99+	National Smelting Co., Cleveland, Ohio	Al; 99+	Poor		Castin
297	National Aluminum 98-99	National Smelting Co., Cleveland, Ohio	Al; 98–99	Poor		Castin
298	Naval Brass	Generally available [12]	Cu, 60; Zn, 39.25; Sn, 0.75	Fair		D, R,
299	Nichrome V	Driver Harris Co., Harrison, N. J.	Ni, 80; Cr, 20	Good	B, DD, F, R, W	B, CR
300	Nickel	International Nickel Co., New York, N. Y.	Ni, 99.4; C, 0.1; Cu, 0.1; Fe, 0.15; Mn, 0.2; Si, 0.05	Fair	B, DD, F, R, W	B, C,
301	Nickel Clad Steel	Lukens Steel Co., Coatesville, Pa.	Ni, 99.4; C, 0.1; Cu, 0.1, Fe, 0.15; Mn, 0.2, Si, 0.05	Fair	F, R, W	HR,
302	Nickel Silver 18%	Generally available [12]	Cu, 65; Ni, 18; Zn, 17	Fair	B, DD, F, R, W	B, C,
303	Nickel Silver 18%	Generally available [12]	Cu, 55; Zn, 27; Ni, 18	Fair	B, DD, F, R, W	B, C,
304	Nirex	Driver Harris Co., Harrison, N. J.	Ni, 80; Cr, 14; Fe, 6	Good	B, DD, F, R, W	B, CI
305	OFHC	Scomet Engineering Co., New York, N. Y.	Cu, 99.985	Fair	B, DD, F, R, W	B, C,
306	Olympic Bronze	Chase Brass & Copper Co., Waterbury, Conn.	Cu. 96; Si, 3; Zn, 1		B, DD, F, R, W	B, C,
307	P D C P Copper	Phelps Dodge Copper Pro. Corp., New York, N. Y.	Cu, 99.985	Fair	B, DD, F, R, W	B, C,
308	Palladium	Baker & Co., Newark, N. J.	Pd, 99.991	Poor	B, DD, F, R, W	B, C,
309	Phosphor Bronze A	Generally available [12]	Cu, 94.8–95.5; Sn, 4.3–5.0; P	Fair	B, DD, F, R, W	B, CI
310	Phosphor Bronze C	Generally available [12]	Cu, Sn, 7.00–9.00; P, 0.03–0.25			
311	Phosphor Bronze D	Generally available [12]	Cu, 89.5–90; Sn, 10–10.5; P	Fair	B, DD, F, R, W	B, CI
312	Phosphor Bronze F. C.	Generally available [12]	Cu, 88; Zn, 4; Sn, 4; Pb, 4	Good	B	B, CI
313	Phosphorized Admiralty	Scovill Manufacturing Co., Waterbury, Conn.	Cu, 70; Zn, 29; Sn, 1; P. .03	Fair	B, DD, F, R, W	T
314	Pioneer	Pioneer Alloy Prod. Co., Cleveland, Ohio	Ni, 65; Cr; Mo; Fe	Good		
315	Platinum	Baker & Co., Newark, N. J.	Pt, 99.99	Poor	B, DD, F, R, W	B, C,
316	Platinum	J. Bishop & Co., Malvern, Pa.	Pt, 99.95	Poor	B, DD, F, R, W	B, C,
317	Red Brass	Generally available [12]	Cu, 85; Zn, 15	Fair	B, DD, F, R, W	B, CI
318	Rhodio Platinum	Baker & Co., Newark, N. J.	Pt; Rh, 5–40	Good	B, DD, F, R, W	B, C,
319	Roofloy	Amer. Smelting & Ref. Co., New York, N. Y.	Pb; Sn, 0.25; Ca, 0.02, Mg. 0.02; Bi, 0.02	Fair		CR,
320	Silver, Fine [11]	Baker & Co., Newark, N. J.	Ag, 99.9+			
321	Silver, Fine [11]	Handy & Harman, Bridgeport, Conn.	Ag, 99.9+	Fair	B, DD, F, R, W	B, C,
322	Stellite 1	Haynes Stellite Co., Kokomo, Ind.	Co; Cr; W	Poor	B, W	C, we
323	Stellite 6	Haynes Stellite Co., Kokomo, Ind.	Co; Cr; W	Poor	B, W	Weld
324	Super Nickel Clad Steel	Lukens Steel Co., Coatesville, Pa.		Fair	F, R, W	HR,
325	Tantalum	Fansteel Metallurgical Corp., N. Chicago, Ill.	Ta, 99.9+	Poor	DD, F, W	D, R,
326	Tobin Bronze	American Brass Co., Waterbury, Conn.	Cu, 60; Zn, 39.25; Sn, 0.75		B, F, W	B, CI
327	Tophet A	Wilbur B. Driver Co., Newark, N. J.	Ni, 80; Cr, 20			D, H
328	Tungsten	P. R. Mallory & Co., Indianapolis, Ind.	W, 99.8–99.9	Poor	B	R, S,
329	Wolverine Comm. Bronze	Wolverine Tube Division, Detroit, Mich.	Cu, 90; Zn, 10	Fair	DD	T

[10] No measurable penetration. [11] Coin (Ag, 90; Cu, 10), sterling (Ag, 92.5; Cu, 7.5), and clad are also available. [12] Copper and copper alloys are availabl
ton, Mass.; Phelps Dodge Copper Products Corp., New York, N. Y.; Revere Copper & Brass, Inc., New York, N. Y.; Riverside Metal Co., Riverside, N. J.; Sc

oys for Construction of Chemical Engineering

hods of cation	Forms Available	Sulphuric Acid							Hydrochloric Acid						Nitric Acid					Ace	
		Temp.	0.5%	2.5%	10%	25%	60%	95%	Temp.	0.25%	1%	5%	20%	Conc.	Temp.	0.5%	5%	20%	65%	Temp.	0.5%
F	R, S, T, W																				
	Castings																				
	Castings																				
		High strength casting alloy																			
	Castings																				
		Castings of moderate corrosion resistance																			
	Castings																				
	Castings																				
	Castings																				
	Castings																				
	D, R, T, W	Applications include valves and condenser tube sheets																			
F, R, W	B, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R	R	R	R	Room Boiling	R R	R R	R	R		Room Boiling	R R	R R	R	R		Room Boiling	R R
F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R <.005 R .010	R <.005 R .01-.03	R <.005	R <.005	R <.010	0.070	Room Boiling	R <.005 R .016	R <.010 R .035	R <.015	R .040	R .060	Room	R <.010				Room Boiling	R <.005 R <.005
W	HR, P, S	Room Boiling	R <.005 R .010	R <.005 R .01-.03	R <.005	R <.005	R <.010	0.070	Room Boiling	R <.005 R .016	R <.010 R .035	R <.015	R .040	R .060	Room	R <.010				Room Boiling	R <.005 R <.005
F, R, W	B, C, CR, D, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
F, R, W	B, C, CR, D, P, R, S	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
F, R, W	B, CR, HR, P, R, S, W	Resists corrosion of organic acids in food and dairy products, and oxidations at high temperatures. Used as sheath for wire elements in heating devices																			
F, R, W	B, C, CR, D, HR, P, R, S, T, W	Immune to attack of dilute sulphuric acid and acetic acid in complete absence of air. In general copper can be used with dilute acids and caustic alkalis																			
F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R					Room Boiling	R R	R				Room	R				Room Boiling	R R
F, R, W	B, C, D, CR, HR, R, T, W	Immune to attack of dilute sulphuric acid and acetic acid in complete absence of air. In general copper can be used with dilute acids and caustic alkalis																			
F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R	Room Boiling	R R	R R	R R	R R	R	Room Boiling	R R	R R	R	R	Room Boiling	R R
F, R, W	B, CR, D, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
F, R, W	B, CR, D, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
	B, CR, D, P, R, S	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R						Room Boiling	R R
F, R, W	T	Primarily used for condenser and heat exchanger tubes																			
F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
F, R, W	B, CR, D, P, R, S, T, W	Primarily used for condenser and heat exchanger tubes, piping, flexible hose																			
F, R, W	B, C, CR, D, HR, P, R, S, T, W	Room Boiling	R R	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	CR, R, T	Room	R.0003	R.0005	R.001	R.002	R.003	R.004													
		Room Boiling	R R	R R	R R	R R	R	R	Room	R	R	R	R	R						Room Boiling	R R
F, R, W	B, C, CR, D, P, R, S, T, W	Room 158° F.	R R	R	R.0007 R.0047	R	R	R	Room Boiling	R R	R R	R R	R R	R R						Room Boiling	R R
	C, weld rod	Room	R	R	R	R	R	R												Room Boiling	R R
	Weld rod	Room	R	R	R .004	R	R	R												Room Boiling	R R
W	HR, P, S	Room Boiling	R R	R R	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	R							
, W	D, R, S, T, W	Room Boiling	R[10] R[10]	R[10] R[10]	R[10] R[10]	R[10] R[10]	R[10] R	R[10]	Room Boiling	R[10] R[10]	R[10] R[10]	R[10] R[10]	R[10] R[10]	R[10] R[10]	Room Boiling	R[10] R[10]	R[10] R[10]	R[10] R[10]	R[10] R[10]	Room Boiling	R[10] R[10]
W	B, CR, D, HR, P, R, S, T, W	Used largely for its resistance to corrosion by sea water and for welding rod																			
	D, HR, R, W	Room						R							Room Boiling	R R	R R	R R	R R	Room Boiling	R R
	R, S, W	Primarily used for electrical contacts and furnace elements																			
	T																				

s are available from such companies as the following: American Brass Co., Waterbury, Conn.; Bridgeport Brass Co., Bridgeport, Conn.; Bristol Brass Corp., Bristol, C
de, N. J.; Scovill Mfg. Co., Waterbury, Conn.; Seymour Mfg. Co., Seymour, Conn.; Wolverine Tube Co., Detroit, Mich.

ngineering Equipment

Nitric Acid					Acetic Acid					Phosphoric Acid				Sodium Hydroxide				Sodium Hypochlorite			Resistance		No.
...mp.	0.5%	5%	20%	65%	Temp.	0.5%	10%	80%	100%	Temp.	10%	50%	85%	Temp.	0.5%	50%	70%	Temp.	5% free Cl	20% free Cl	Heat	Abrasion	
																							288
																							289
																						Fair	290
																							291
																						Fair	292
																							293
																						Good	294
																						Good	295
																						Poor	296
																						Poor	297
																						Good	298
...m ...ing	R R	R R	R	R	Room Boiling	R R	R R	R R	R R					Room Boiling	R R	R R	R R				Good	Poor	299
...m	R <.010				Room Boiling	R <.005 R <.005	R <.005 R <.010	R <.015 R <.020	R <.005 R <.015	Room	R <.005	R <.005	R <.015	Room Boiling	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.005				Good	Good	300
...m	R <.010				Room Boiling	R <.005 R <.005	R <.005 R <.010	R <.015 R <.020	R <.005 R <.015	Room	R <.005	R <.005	R <.015	Room Boiling	R <.0001 R <.0001	R <.0001 R <.0001	R <.0001 R <.005				Good	Good	301
					Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R	Fair	Good	302
					Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R	Room Boiling	R R	R R	R	Room	R		Fair	Good	303
...sheath for wire elements in heat-																					Good	Poor	304
...can be used with dilute acids and																					Fair	Fair	305
...m	R				Room Boiling	R R	R R	R	R					Room Boiling	R R	R R	R R	Room Boiling	R R				306
...can be used with dilute acids and																					Fair	Fair	307
...m ...ing	R R	R R	R	R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Good	Poor	308
					Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R	R	Room Boiling	R R	R	R	Room	R			Good	309
																							310
					Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R	R	Room Boiling	R R	R	R	Room	R			Good	311
					Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R	R	Room Boiling	R R	R	R	Room	R			Good	312
																					Good	Fair	313
																						Good	314
...m ...ing	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Good	Poor	315
...m ...ing	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room	R	R	Good	Poor	316
																					Fair	Fair	317
...m ...ing	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	R R	Room Boiling	R R	R R	Good	Good	318
										Room	R.001	R.002	R.003									Fair	319
					Room Boiling	R R	R R	R R	R R	Room Boiling	R R	R	R	Room Boiling	R R	R R	R R						320
					Room Boiling	R R	R [10] R	R R	R R	Room	R	R	R	Room Boiling	R R	R R	R R				Poor	Poor	321
					Room Boiling	R R	R R [10]	R R	R [10] R [10]									Room		R [10]	Good	Good	322
					Room Boiling	R R	R R.003	R R	R R.011												Good	Good	323
																							324
...m ...ing	R [10] R [10]	R [10] R [10]	R [10] R [10]	R [10] R [10]	Room Boiling	R [10] R [10]	R [10] R [10]	R [10] R [10]	R [10] R [10]	Room Boiling	R [10] R [10]	R [10] R [10]	R					Room	R [10]	R [10]	Poor	Fair	325
																							326
...m ...ing	R R	R R	R R	R R	Room Boiling	R R	R R	R R	R R	Room	R			Room Boiling	R R	R R	R R				Good		327
																					Good	Fair	328
																							329

...ort, Conn.; Bristol Brass Corp., Bristol, Conn.; Chase Brass & Copper Co., Waterbury, Conn.; Mueller Brass Co., Huron, Mich.; New England Brass Co., Taun-

Terms Us...

Composition

"Essential nominal chemi... position" refers to the princip... stituents and the approxima... portion present. When ... shown without percentage ... assumed that it represent... ance of the composition.

Forms Available

B = bars
C = castings
CR = cold rolled
D = drawn
HR = hot rolled
P = plates
R = rods
S = sheets
T = tubes
W = wire

Methods of Fabrication

B = brazing
DD = deep drawing
F = flanging
R = riveting
W = welding

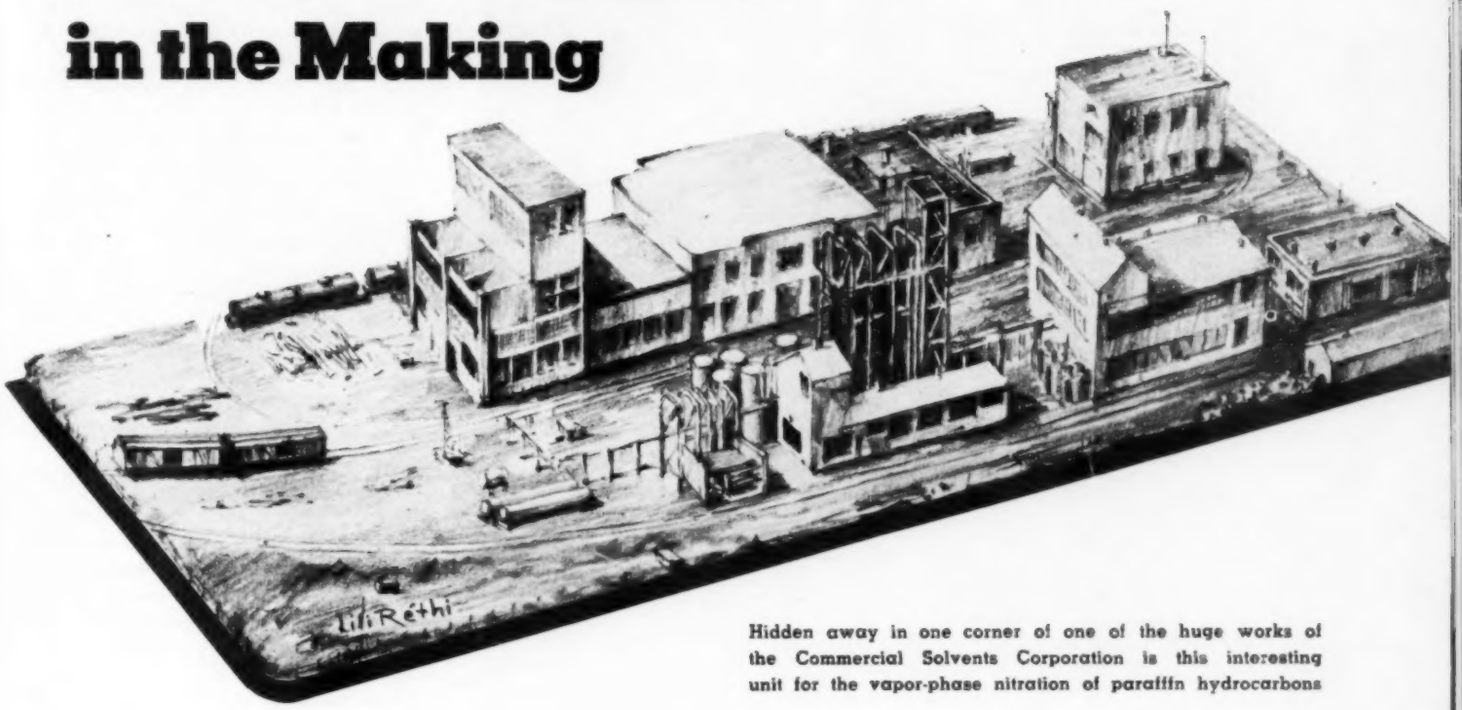
Corrosion Data

R indicates that the metal ... should give reasonably good ... ance under the conditions of ... tration and temperature ... but it does not imply any gua... of satisfactory service. The ... following the R are the report... sult of laboratory corrosion ... inches penetration per year. ... space is left blank either ther... insufficient data available to ... the extent of resistance or more ... plete information concerning ... vice required is necessary.

Footnotes

Superior numbers refer to foot...

Post-War Industry in the Making



Hidden away in one corner of one of the huge works of the Commercial Solvents Corporation is this interesting unit for the vapor-phase nitration of paraffin hydrocarbons

SIDNEY D. KIRKPATRICK *Editor, Chemical & Metallurgical Engineering*

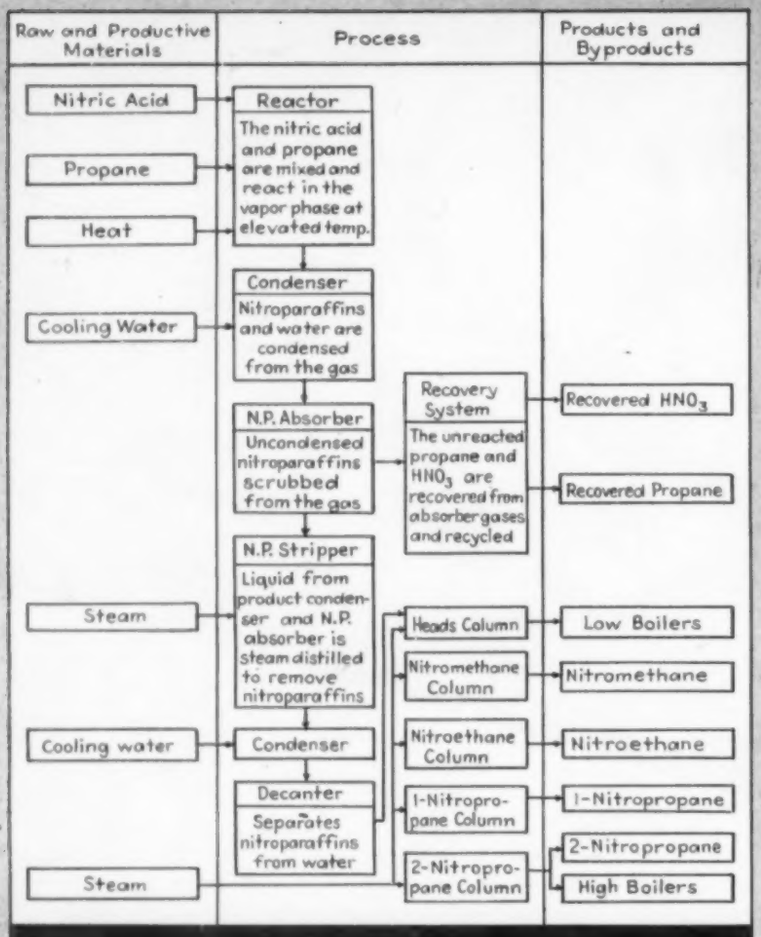
Chem. & Met. INTERPRETATION

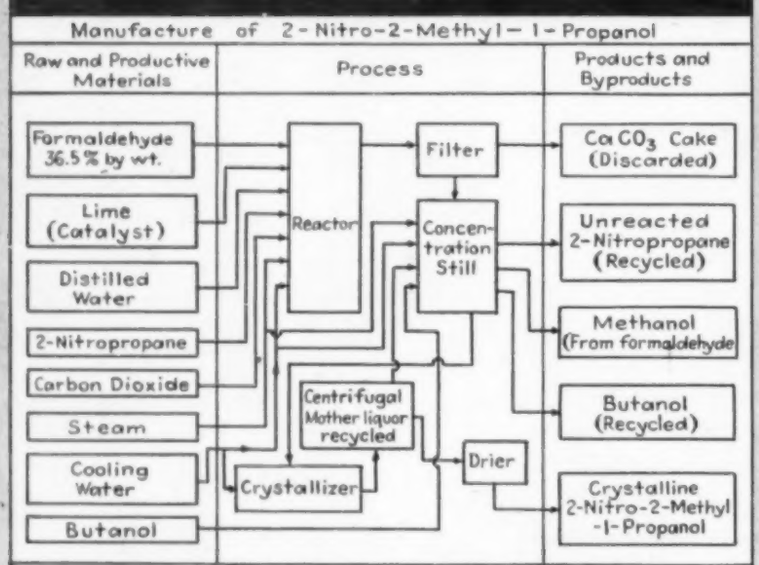
Corrosion-resistant metals and alloys have made possible the successful commercial development of the vapor-phase process for the nitration of petroleum hydrocarbons, thereby producing basic raw materials for future chemical industries. The nitroparaffins and their derivatives are already demonstrating their usefulness in a wide range of chemical and process applications. This article is the first to describe their production in the new model plant at Peoria, Ill., and to show by typical flowsheets how chemical engineers are using these versatile materials to produce many valuable derivatives. Other equally important applications await exploration.—*Editors.*

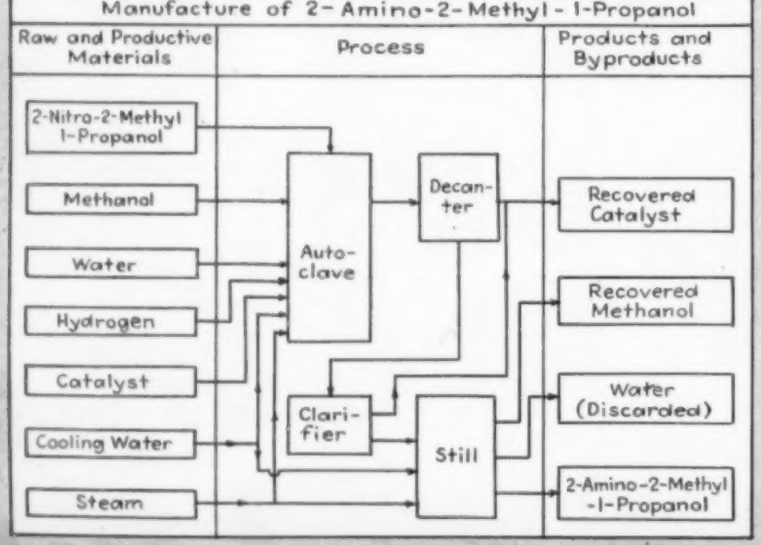
A NEW FAMILY of organic chemicals is making its bid for industrial recognition. A few years ago they were regarded as laboratory curiosities—new playthings for the research chemists and molecule jugglers. Today the nitroparaffins are being shipped in tank cars to serve as the basic raw materials for new industries. Exploratory research is continuing to develop hundreds of new derivatives and many of these are finding jobs as building stones in present and post-war projects. Thus the whole development is following the familiar pattern of industrial growth as an entirely new field of organic chemistry widens its circles of usefulness and influence.

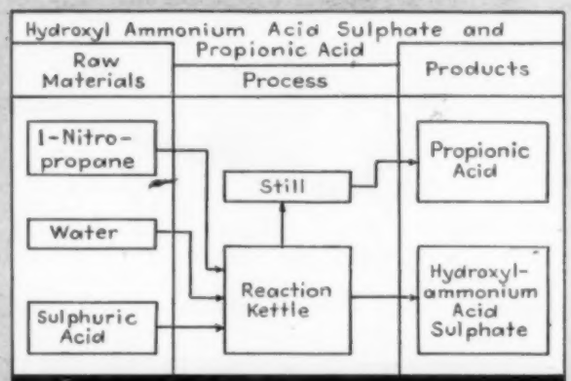
How many of us realize, however, that the nitroparaffin industry itself would scarcely have been possible had it not been for the modern corrosion- and heat-resistant materials available for plant and equipment construction? A new process of vapor-phase nitration required the handling of nitric acid at temperatures far above its boiling point—a field in which there was practically no experience on which to draw. The problem was further complicated by the reaction products that behaved badly at high temperatures. Fortunately in the period directly after the first World War we had learned a lot in this country about the use of high chromium iron and the chromium-nickel steels. It was this knowledge, increased by costly research and experimentation, that made possible the construction of the first commercial plant in the world to produce the nitroparaffins by vapor phase nitration. It has been in commercial operation since April, 1940. At present it produces the four best known of the NP's—nitromethane, nitroethane, 1-nitropropane and 2-nitropropane—as well as approximately 20 of their important derivatives.

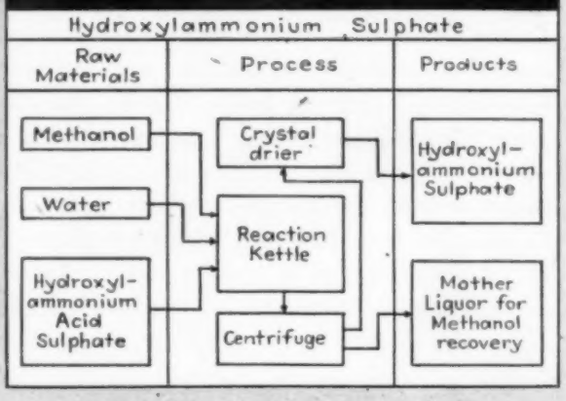
As is well known to most *Chem. & Met.* readers, the vapor-phase nitration process has been based on results of research at Purdue University carried out during the past dozen years by Prof. Henry B. Hass and his associates in the Purdue Research Foundation. About 1935 the Commercial Solvents Corp. arranged with the Purdue Research Foundation for the commercial exploitation of the vapor-phase nitration process. Research on this process was started immediately in the corporation's laboratories at











Terre Haute, Ind., and at the same time various fellowships were established at Purdue University, principally to work on the derivatives of the nitroparaffins.

By 1937 the project was ready for its first pilot plant, which was set up in Terre Haute. Experience thus obtained led to the design and construction during 1939 of the first commercial plant at Peoria, Ill. It was built by E. B. Badger & Sons of Boston as a self-contained unit, dependent only upon the general plant for steam, water, electricity and sewer facilities.[1]

Construction was unusually costly due, as previously mentioned, to the large amount of expensive alloys that were required to resist the severely corrosive conditions. As is so often the case, laboratory corrosion tests were not generally applicable to plant conditions. Hence it was necessary to carry on considerable experimentation in the construction of the pilot plant. To get the benefit of as much experience as possible from the metal suppliers, the stainless steels and other alloys were purchased from a

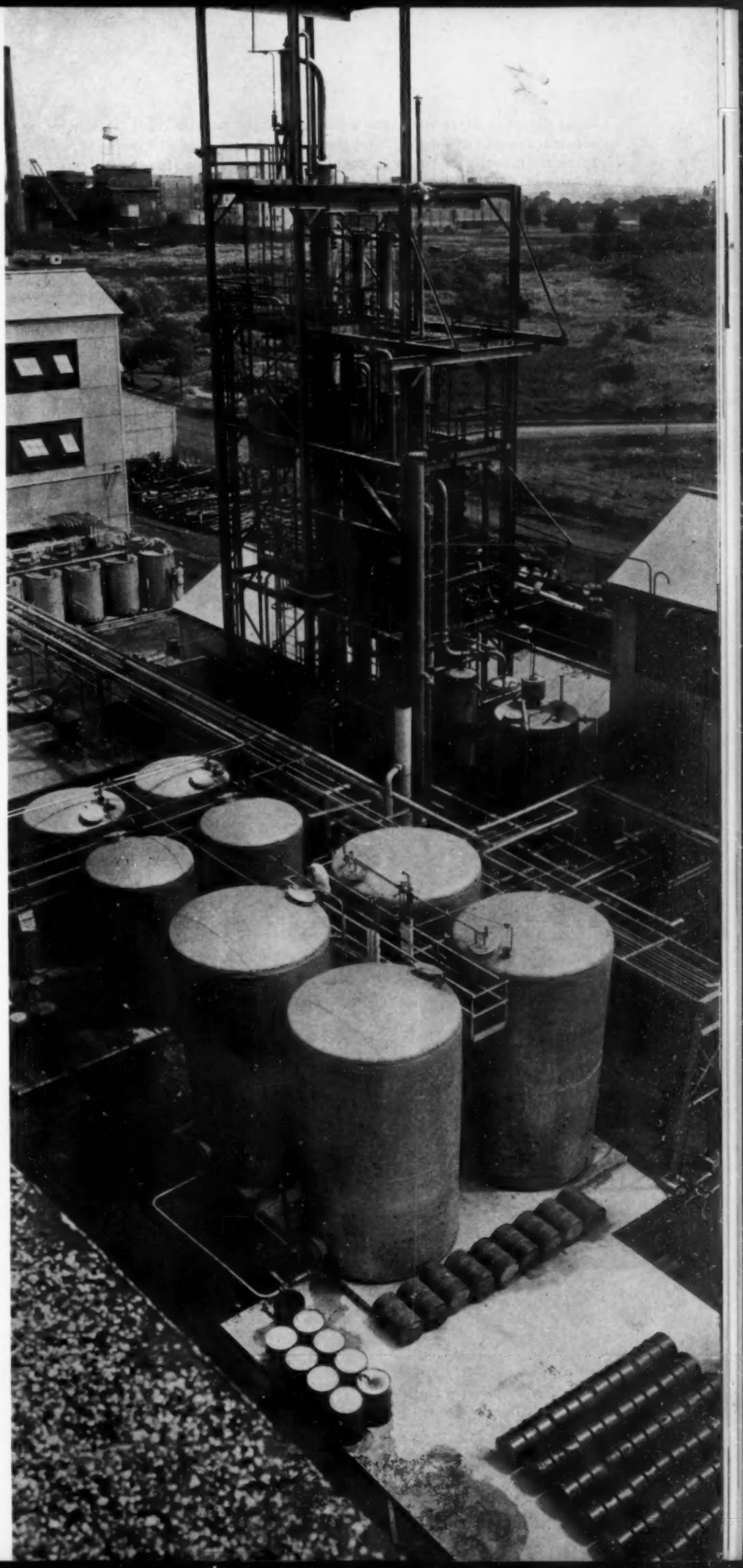
[1] A much larger plant is on the drafting boards for post-war construction. S.D.K.

number of different manufacturers. All were given an opportunity to test out their products and to bid for part of the business. This process of splitting up the contract proved to have both advantages and disadvantages. It helped the corporation's engineers as well as the suppliers to evaluate the materials under conditions of actual service. In a few cases, however, inexperienced concerns found it necessary to replace their products and costly delays resulted. No single alloy was found to be outstanding for all applications. Some large pieces of equipment made of alloys that satisfactorily handled hot vapors were seriously damaged by superheated nitric acid in liquid phase. In other instances the reverse happened. Gradually, however, the corrosion problems that appeared to present almost insurmountable difficulties have been overcome.

Long-range corrosion studies are still being conducted in the Peoria installation. It is not uncommon to find different sections of various columns composed of different alloy steels. Likewise, performance studies are being made in nearly every place where spare pieces of equipment have been installed or where duplicate units can be used for the same purpose. Thus the equipment as well as the materials of different manufacturers are being studied.

The process used at Peoria for the commercial production of the nitroparaffins consists of three steps or stages: (1) The high-temperature nitration of propane in vapor phase; (2) separation of reaction products and recovery of unreacted materials for recycling and (3) fractional distillation and purification of the nitroparaffins. Thus it will be seen that the two principal raw materials are propane and nitric acid. Both are received at the plant in tank cars, the former coming from a mid-continent petroleum refiner and the acid from a nearby chemical manufacturer. Chrome-iron tanks are used for the storage of the nitric acid, which is pumped to process in Labour centrifugal pumps, also of chrome iron.

The nitration unit itself, or reactor, as it is called, is housed between reinforced masonry walls and consists of a gas-fired, refractory-lined furnace built by the Surface

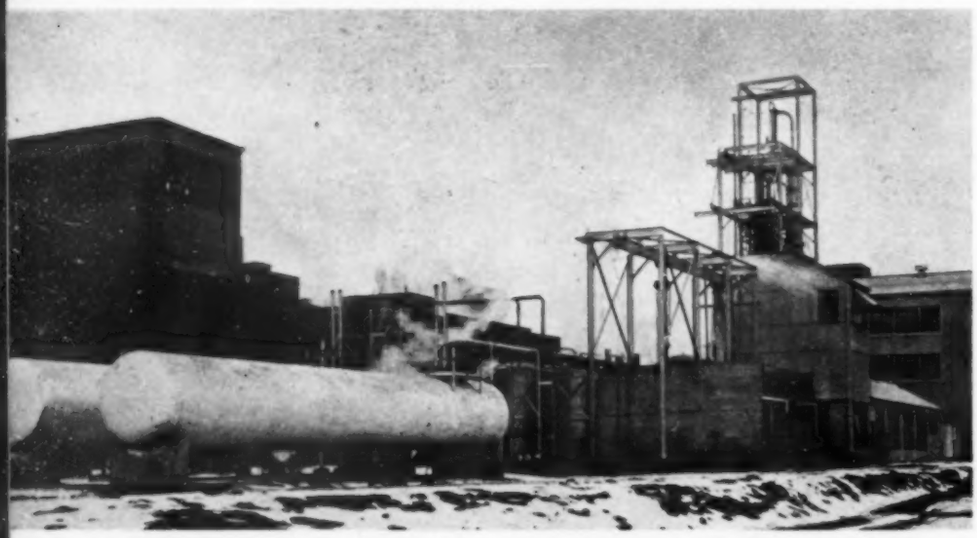


Aluminum storage tanks, stainless steel fractionating towers and piping, asbestos-cement buildings—help the chemical engineer to solve corrosion problems involved in nitroparaffin manufacture

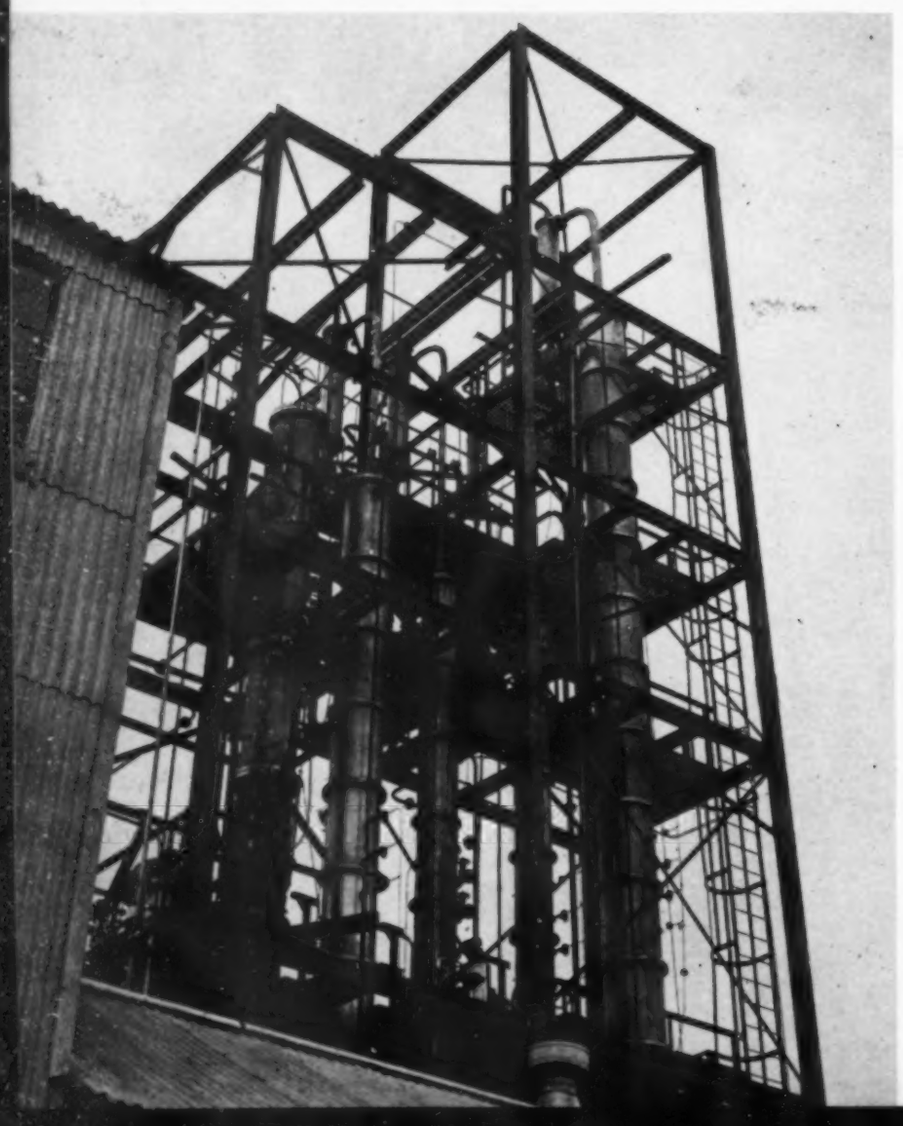
Combustion Co. Here the nitric acid is heated to about 400 deg. C. and the vapors are mixed with propane under pressure of about 150 psi. The highly exothermic reaction takes place instantly and unless the products of the reaction are rapidly cooled, there is a progressive oxidation of the hydrocarbons to CO and CO_2. This cooling is accomplished with water in a long tubular heat exchanger and condenser.

In addition to the nitroparaffins the condensate contains water introduced with the nitric acid and that formed by the reaction. Nitroparaffins still remaining in the gas are removed by counter-current scrubbing operations, after which the crude NP's are recovered from the scrub liquor and condensate by steam distillation. The crude nitroparaffins are decanted from the condensed steam and separated into the individual components by continuous vacuum distillation and fractionation. As will be noted from the accompanying flow diagram (Fig. 1), there are six fractions—the four commercial NP's—nitromethane, nitroethane, 1-nitropropane and 2-nitropropane—and the low and high boiling fractions. Nitration gases from the condenser and nitroparaffin absorber contain unreacted propane and oxides of nitrogen which are recovered and recycled.

Successful operation of a continuous vapor-phase nitration plant requires the maintenance of uniform temperatures, pressures and flows throughout the system. The nitration process, the product condensation and recovery, the distillation of the crude paraffins and the recovery and



Chrome-steel tanks for nitric-acid storage in foreground. Notice also concrete barriers shielding the gas-fired furnace in which the nitration is effected



Open-type construction made possible by use of corrosion-resistant materials

recycling of the unconsumed reactants must all operate steadily and in constant balance with one another. This can only be accomplished by complete instrumentation and maximum use of automatic control. Some idea of the magnitude of the control problem and the number and variety of the instruments needed can be gathered from the fact that the control panel for the Peoria plant is nearly 50 ft. long and contains 30 recording and controlling instruments and over 50 indicating devices, in addition to the numerous automatic controls that make it possible for two men per shift to operate the entire plant.

Before describing the adjoining plant for the production of derivatives, it may be of interest to list some of the many rapidly increasing uses for the nitroparaffins themselves. We naturally think of them first as solvents for they have much in their favor in this field. They are medium-boiling, mildly odored and have strong dissolving power for many difficulty soluble materials. For example, the nitropropanes will dissolve hundred of waxes, natural resins and gums, tars and pitches, coating materials, oils, fats, dyes and

organic chemicals. Sometimes the solubility is increased ("activated") by the presence of alcohol. As solvents for cellulose acetate, they have certain advantages over low-boiling materials that cause poor flow or "blushing" of lacquers and over the high-boiling, slowly-evaporating solvents that delay the final hardening of the film. The nitroparaffins are among the most powerful solvents known for vinyl acetate-vinyl chloride polymers and can be advantageously used with the higher ketones in most vinyl resin-solutions.

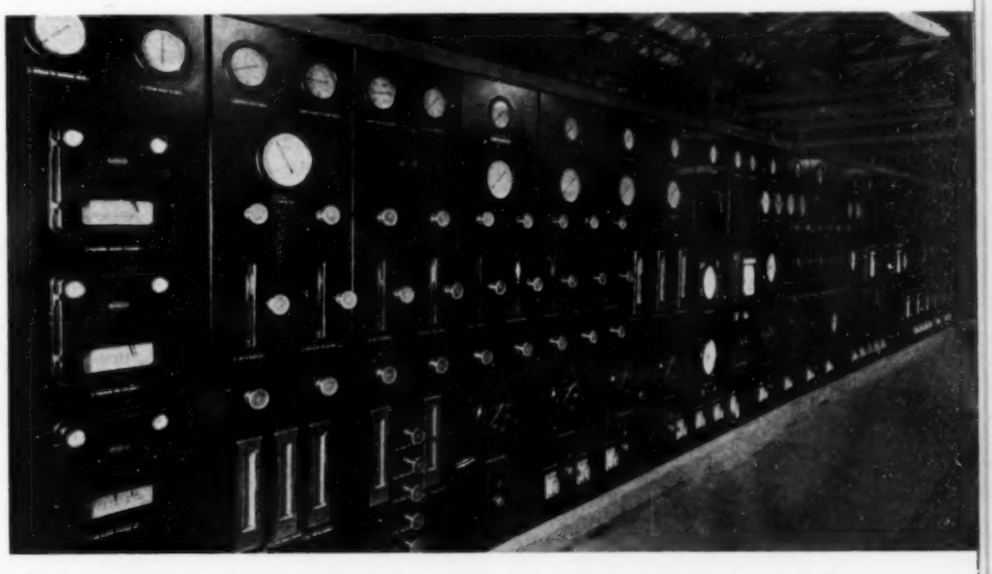
Immediately adjoining the NP plant is the large three-story building in which many of the more important chemical derivatives are now being manufactured. As will be noted from the accompanying illustrations, the equipment in this plant is that of a thoroughly modern factory for the production of fine chemicals. At present approximately 20 derivatives are being made at Peoria but the plant has been equipped to provide extreme flexibility in all of its operations.

Typical of the amino-hydroxy derivatives, of which five are now production, is the manufacture of 2-nitro-2-methyl-1-propanol shown in the accompanying flow diagram (2).

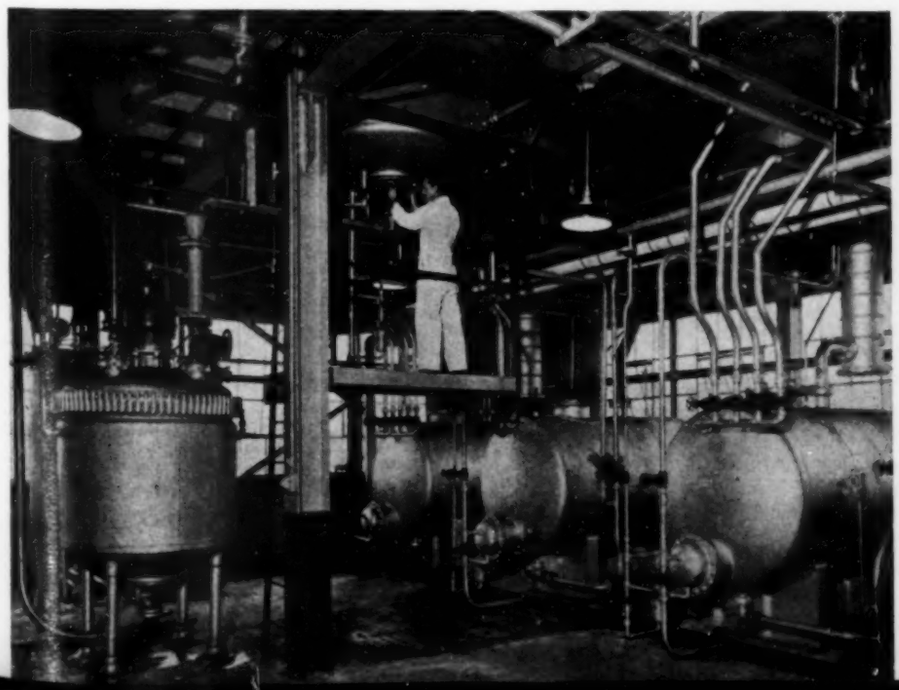
Typical of the animo-hydroxy derivatives, of which five are now produced at Peoria, is the manuture of 2-amino-2-methyl-1-propanol shown in Fig. 3. This is one of the most versatile of the emulsifying agents available today for the preparation of water dispersions of fats, oils, waxes and resins. Cosmetic creams and lotions made from this product are said to show exceptionally high stability in respect to color and consistency. Comparable advantages are claimed for automobile cleaner-polishes, shoe and leather dressings, mineral oil emulsions and other textile finishing compounds. The amino-hydroxy derivatives also readily undergo a variety of chemical reactions and are therefore widely used in synthesis.

One of the simplest of chemical compounds—in the borderland between the organic and inorganic kingdoms—is hydroxylamine, NH_2OH. It has been known for many years as a useful, active reagent for chemical synthesis but its application has been restricted because of its high price and limited availability. Now, however, it can be readily made in the form of its salts merely by the hydration of nitropropane in the presence of an acid (See Fig. 4). The cheapest of these salts now available is hydroxyl ammonium acid sulphate. This is an economical base for the synthesis of dyestuffs, pharmaceuticals, resins, flotation agents and many other organic chemicals. In reactions where high purity is of importance, hydroxyl ammonium sulphate, produced by reaction with methanol (See Fig. 5) is recommended.

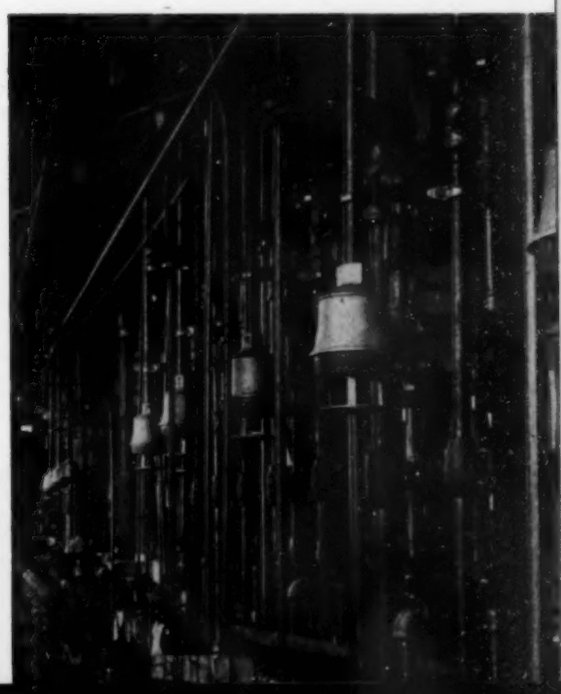
These are only a very few of many derivatives of the NP's that are being made at Peoria or in the Terre Haute plant of Commercial Solvents. They will doubtless suggest some of the other processes and applications which are daily extending these products into ever wider fields of usefulness.



Above—Control panel almost 50 ft. long, with 30 controlling devices and over 50 indicating devices



Below—Many new nitroparaffin derivatives are made in this model chemical plant



Below—This maze of piping is required to maintain uniform temperature, pressure and flow of materials

FORD Makes Magnesium

GERALD ELDRIDGE STEDMAN *Webster Hall, Detroit, Mich.*

Chem. & Met. INTERPRETATION

"Somewhere in Michigan" another plant gets under way for the commercial production of the silvery white metal that means so much to our war effort. Behind this development lies the keen personal interest of Mr. Henry Ford, who was among the first to put the new light alloys of magnesium to practical application on a large scale. Behind it also lies the genius and resources of the chemical and metallurgical laboratories of the Ford Motor Co., which accepted the government's challenge to build and operate a plant using the ferro-silicon process recently described in these pages. Within the limits of voluntary censorship, Mr. Stedman tells a story in this article that spells additional trouble for our enemies.—*Editors.*

Under the sheltered section of this building, the first furnace was producing magnesium while roof sections and steel framework were being put in place for the rest of the building. Less than six months after the first construction work began, the first section of the building was virtually completed and workmen were pushing construction of the second

HIGHLIGHTING the importance of aircraft in warfare, the "little World War" stimulated interest in the light alloys. Germany, in particular, went about expanding its capacity for magnesium production. The I. G. Farbenindustrie, A.G., and the Wintershall potash group, who together provide the entire German output, had done so well by 1938 that further extension of productive capacity was prohibited by law. Methods of production varied, but both groups depended primarily upon the electrolysis of fused magnesium chloride obtained either in the waste liquors of the Stassfurt potash industry, or from selected carnallite ores. Japan, too, began to imitate its Axis partner in 1932, when its production was only 24 tons, but by 1938 the Japs were producing 1,200 tons, most of it by the Nichiman company at its Ube plant in Yamaguchi Prefecture, again using the electrolytic process on magnesium chloride recovered from brines or obtained by chlorinating calcined magnesite.

Our own magnesium industry, as previously reported in *Chem.& Met.* (Nov. 1941, p. 76-85) was started in 1915 by several producers, but since 1927 the major commercial output has come from the Dow Chemical Co. of Midland, Mich. The government has reported that production in 1940 had reached 6,250 tons, and even before Pearl Harbor plans were announced for multiplying this output by fifty fold.

Mr. Henry Ford traces his early interest in magnesium to his great friendship for the late Dr. Herbert H. Dow. Many years ago he bought the first automobile trailer to be made of Dowmetal. This was finally evolved into a fleet of chassis-less semi-trailers, each weighing 5,700 lb., yet capable of carrying three good-sized automobiles. This same interest in magnesium led ultimately, under the challenge of the Victory Program, to the building and operating of Ford's own foundry for molding magnesium alloy castings. A magneto adapter for aircraft engines was poured on Jan. 14, 1941, as the first magnesium casting of that now mammoth plant. Sad day for Hitler.

Meanwhile, the Ford chemical and metallurgical laboratories continued to explore all phases of magnesium production, as well as its application. As the government magnesium program developed, it had become evident that other magnesium production processes would be needed to furnish quick and certain production with a minimum use of power and critical chlorine. A special committee of the National Academy of Sciences was formed to hunt for other meritorious processes. Its conclusion was that the ferro-silicon process, which had been developed in the Canadian National Research Laboratory (see *Chem.& Met.*, April, 1942, p. 87)

would give the best results with the minimum time-cost risk.

On Dec. 24, 1941, the N.A.S. Magnesium Committee, headed by Dr. Zay Jeffries of the General Electric Co., and Dr. Howard W. Russell, of Battelle Memorial Institute, visited the Ford Motor Co. to find out what it would do about producing magnesium in quantities. Although the work of his own engineers had pointed toward the further development of a carbo-thermic process as the most promising and economic, Mr. Ford agreed to accept the committee's recommendation that the ferro-silicon process should be used. His only desire was to do what the government wanted done to meet its war needs.

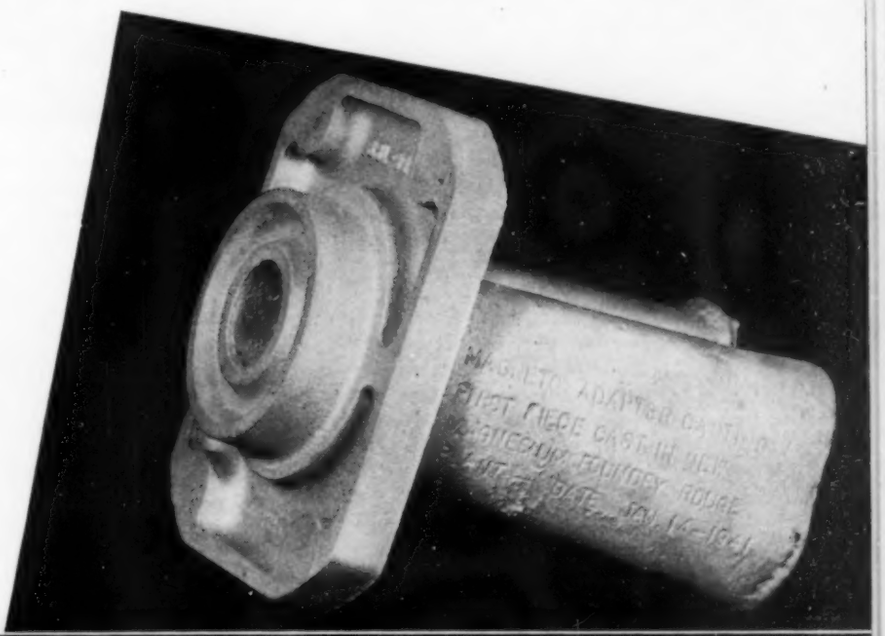
Within a week after the N.A.S. Committee's visit, special iron castings were made to serve as a retort and experimental production of magnesium was started by the ferro-silicon process. This convinced Ford engineers that the metal could be produced on a full production basis, and within three days after the letter of intent of the Defense Plant Corp. was received (Jan. 13, 1942) pile drivers were operating on a new plant site. Having no pattern to study in the United States or Canada, Ford engineers originated their own plan and copying the tar-paper cocoon shelter from the Airplane Engine Plant, contractors started to pour cement on January 27, just about a month after the initial approach by the N.A.S. Committee.

In the Spring of 1942, gas fires were lighted in the first furnace and magnesium was first produced on a commercial basis shortly afterward, less than two months after the first furnace brick were laid. Meanwhile, workmen were pushing construction on the next section of furnaces, and the smelter began its round-the-clock schedule to the Victory effort.

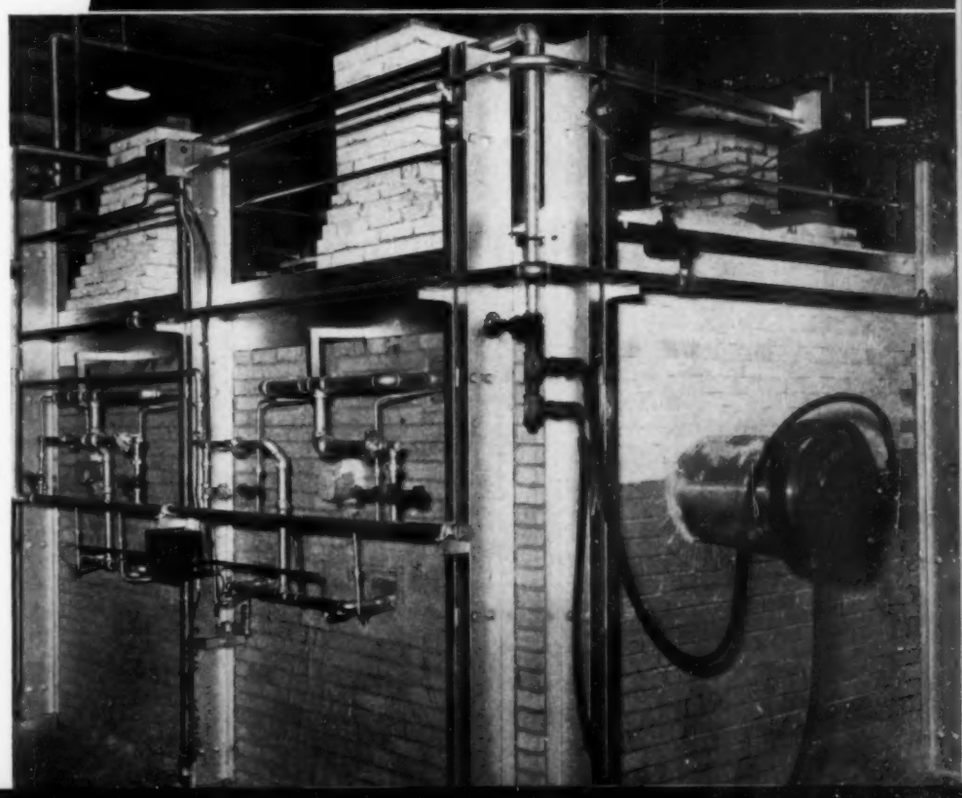
While construction tempo was proceeding, retorts of varying alloys and sizes were tested in a pilot furnace to determine the most efficient mass production set-up. A 20-in. diameter was first tried, but the time required to raise the tube to the proper temperature was too long. Other diameters from 6 in. to 20 in. were experimented with and more than a thousand different runs were concluded to find the most economical methods. Eventually a retort of 22 ft. in length, with 10-in. i.d., made from chrome-nickel steel, proved most satisfactory.

The ferro-silicon process of producing magnesium metal is relatively simple—at least in outline. Dolomite, the naturally occurring calcium-magnesium carbonate, is one of the most abundant of our limestones, with deposits widely scattered throughout the United States. Ferro-silicon, of course, is made in the electric furnace from silica, iron and carbon. The combination of the dolomite and ferro-silicon, properly proportioned in a vacuum at a high temperature causes the magnesium to be driven off as a vapor. Coming into contact with a cool surface, this condenses while the iron rides along on the coat-tails of the silicon.

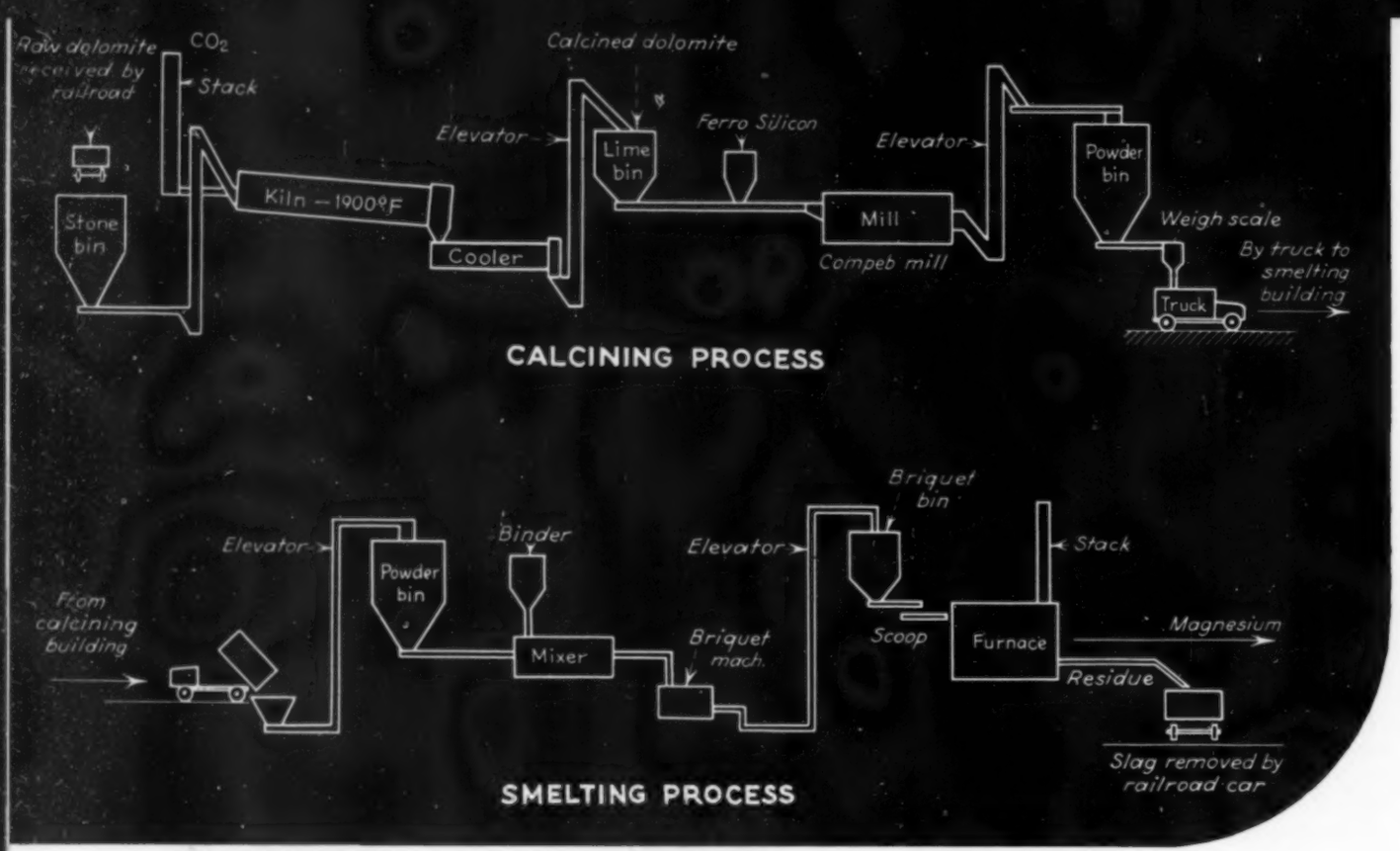
The production flow at the Ford plant proceeds in two stages—calcining and smelting, as shown in the accompanying sketch. From the



First magnesium casting made in Ford foundry Jan. 14, 1941 was this magneto adapter for an airplane engine



Experimental production of magnesium was being conducted in a pilot furnace while construction of the magnesium plant was under way. Retorts of different alloys and various sizes were tested to find a retort that would produce magnesium most efficiently and economically. Water coolers were used at first to condense the metal vapor, but later tests proved air cooling was just as efficient



Flowsheet for the production of magnesium from dolomitic limestone by the ferro-silicon process as used by Ford Motor Co. A former cement plant is used for calcining the Michigan dolomite. Half the weight of the stone is removed as CO_2 during calcining

Michigan quarries, dolomitic limestone is brought to a former cement plant to be dehydrated, powdered and calcined. The burning process removes approximately 50 percent of the weight of the raw stone in the form of carbon dioxide.

The calcined dolomite and precrushed ferro-silicon are proportioned into large compartment ball mills which have the dual function of powdering and mixing both materials. They further compact the mixture so that there is less tendency for segregation during storage.

This dehydrated dolomitic lime and ferro-silicon mixture is stored, transported by trucks to the magnesium smelting plant, where, in the briquetting unit, the dolomitic lime (mixed with 75 percent of ferro-silicon in a ratio of slightly less than 6-to-1) is compressed into handy shape. The finished briquettes are then ready for the smelter.

Ford's experience in briquetting glass batches was helpful in the production of such enormous quantities of briquettes. The nature of the material caused special design of auxiliary equipment and presses were developed as rolls with briquette-mold recesses in them, the charge being formed into briquettes at the bite of the rolls.

The magnesium smelting furnaces are arranged in a number of rows. Each furnace is 19 ft. high, 16 ft. wide, and 18 ft. long. Through the middle of each runs two tiers of Nichrome pipe, 11 to each furnace, banked six on the bottom row, and five on the top. These are the retorts. They are 22 ft. long, 13 ft. of which is in the heat zone, and 31 in. of which projects from each end of the furnace. Furnaces are designed to use either 10- or 12-in. i.d. retorts. These are supported inside the furnace by refractory brick arches. Split steel sleeves fit inside each retort on the ends projecting from the furnace. It is on these that the magnesium condenses and crystallizes.

Smelting must be carried out in a high vacuum. This is accomplished by manifolding each retort into a vacuum pump. A 1.5-in. pipe leads from each retort and into one of four furnace manifolds, which, in turn, lead to the floor beneath each furnace where they connect with four vacuum pumps each driven by a 5-hp. electric motor. These pumps, rated at 100 cu.ft. of air per min., remove the air from the retorts. Metal caps placed over the retort ends facilitate in maintaining the high vacuum.

The briquettes are preheated above the furnace proper before loading into the retort. Furnace exhaust gases are circulated through this area on their journey to the chimney, and the briquettes are thus heated. As the retorts open for charging, these preheated briquettes are loaded into the 22-ft. long tubes, the load weight per retort being 350 lb. The end caps are then attached and the vacuum pumps started.

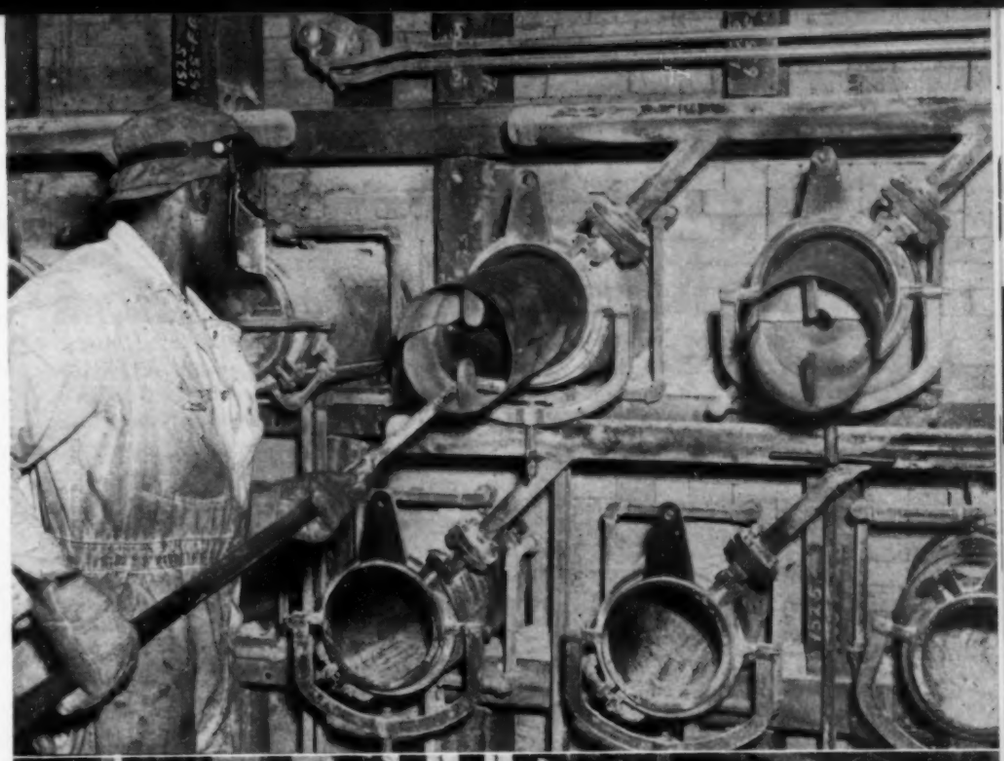
Each furnace is fired by numerous gas jets from each side. They burn purified coke-oven gas and maintain the necessary temperature inside the furnace. This heat, assisted by the vacuum, causes the magnesium to vaporize. An 8-hr. cycle releases the greater proportion of the metal. The vacuum, aside from its necessity in the chemical reaction, tends to draw the magnesium vapors to the ends of the retorts. Here, after some experimenting with water-cooling, it was found that cooler air temperatures at the end-tube portions of the retorts were sufficient to cause the necessary condensation. The metal is deposited on the split iron sleeves lining the extremities of the tubes.

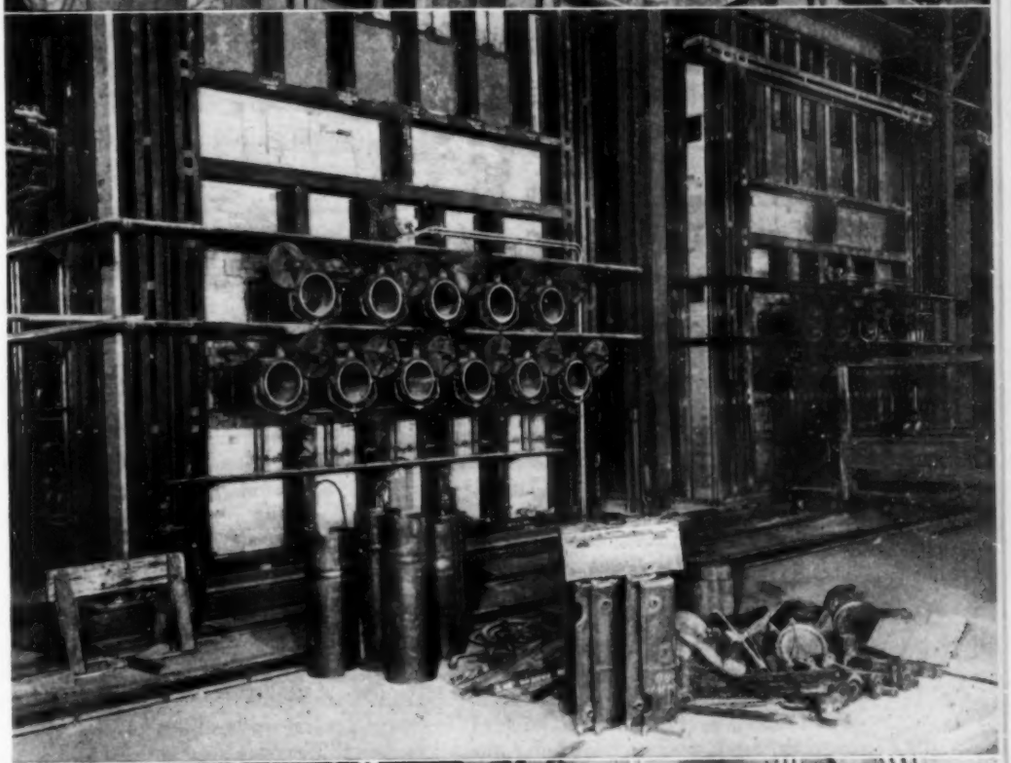
After eight hours of firing, the sleeves, with their magnesium deposits, are withdrawn from the retorts and the crystallized metal removed. Theoretically, 20 percent of briquette weight should be deposited as magnesium. This would represent 70 lb. of metal per charge.

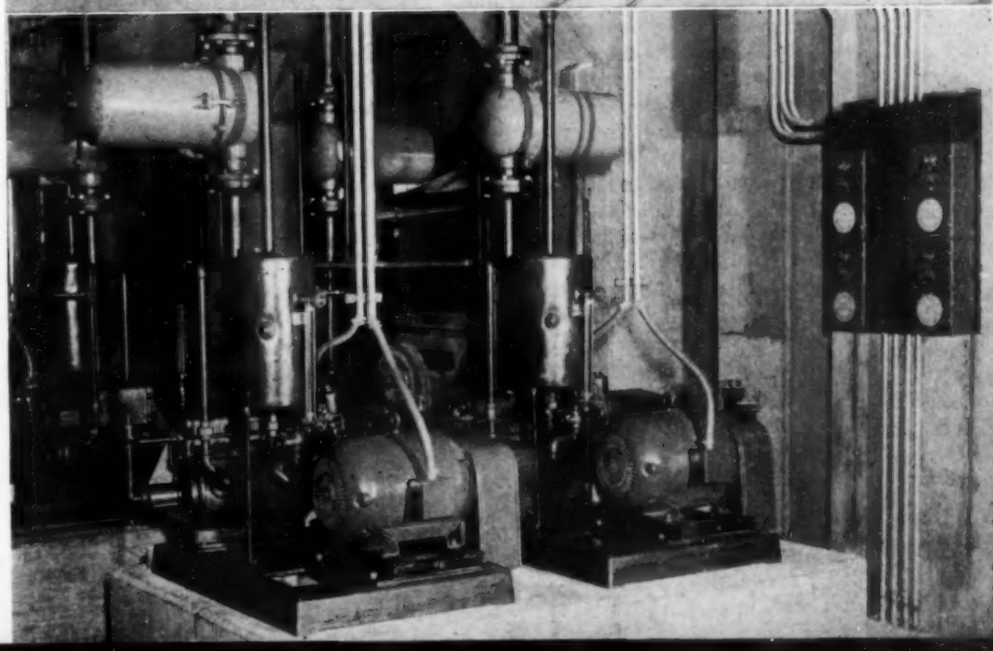
After the magnesium covered

sleeves have been extracted from the retorts, the residue is cleaned out. Because of its high lime content, this could be used for agricultural purposes. Nothing has yet been attempted along this line.

Because of the lack of mechanical equipment, it has been necessary during the first few months of operation to load, tap and clean retorts manually. At first, briquettes were not preheated, but were merely shoveled into a scoop that could be funneled into each retort. Iron sleeves were pulled from tubes by long hooks. Slag was scraped out with long-handled hoes. The mechanization of these tasks is proceeding, and additional daily tonnage per furnace can be expected from such mechanical charging. Censorship prevents disclosure of magnesium smelting production per furnace per day, but it is high, and the furnace operates







Above — Close-up of furnace showing iron sleeves on which the magnesium is deposited

Right — In the smelting of magnesium, briquettes of calcined dolomite and ferrosilicon are charged into long Nichrome retorts. Pure metal is vaporized from the charge and condensed on two-piece iron sleeves lining the ends of the retorts. After eight hours most of the metal is deposited. The sleeves are then withdrawn and the magnesium removed

Below — Four vacuum pumps are required for each furnace. Each is driven by a 5-hp. motor and can remove 100 cu. ft. per min. of air from the retorts

24 hr. each day on eight-hour firing cycles.

This, then, is the story of one of Ford's war achievements, described as closely as censorship permits. The fact that Ford has maintained a mammoth magnesium alloy foundry for better than a year now permits his complete utilization of the advantages of the metal he produces. Ultimately his metallurgists may well develop special alloys of even greater merit than those known. Thus, the completeness of Ford's integrated facilities in producing, casting, machining and fabricating this war metal can give the United States another lifting assurance of ultimate victory. And magnesium is destined to create many revolutions in peacetime mechanical design once its present job is done.

Clays and High-Silica Bauxites For Alumina Production

EDITORIAL STAFF SUMMARY

Chem. & Met. INTERPRETATION

The article below is an abstract of a report prepared by the Advisory Committee on Metals and Minerals at the request of the War Production Board and recently released by the National Academy of Sciences and the National Research Council. The report, signed by Zay Jeffries, reflected the conclusions of the alumina subcommittee, including Francis C. Frary, Oliver C. Ralston, Robert S. Sherwin and John D. Sullivan, and provides an excellent summary of current thinking on the problem of providing sufficient alumina for the war effort without reliance on continued bauxite imports or undue depletion of the known domestic supplies of low-silica bauxite. —*Editors.*

ABOUT 2 lb. of alumina of high purity is required for the production of each pound of metallic aluminum. Projected production of metallic aluminum in the United States is now seven to ten times the peacetime rate a few years ago.

In the past, all the alumina for the production of aluminum in the United States has been obtained from bauxite. Part of the bauxite was mined in the United States—chiefly in Arkansas—and part was imported from Dutch Guiana. All of it was chemically treated in the United States to separate the greater part of the aluminum oxide from the bauxite. The chemical treatment was effected by alkaline solutions, employing the Bayer process. The ingredients of the bauxite other than alumina, such as the compounds of iron, titanium and silicon, constitute the tailings of the Bayer process, and are called "red mud." Lime and soda, used in the processing, are also present. Varying amounts of alumina remain in the red mud, depending upon the characteristics of the bauxite, the effectiveness of the treatment and, in particular, upon the amount of silica originally present in the bauxite. High-silica bauxites result in high alumina loss in the red mud.

Because of this relationship between the silica content of the bauxite and the alumina lost in the Bayer process treatment, there has been an incentive in the past to use low-silica bauxites. Much of the Dutch Guiana bauxite is low in silica and hence is a splendid Bayer process feed. In the domestic bauxites the silica content varies all the way up to 25 or 30 percent. Bauxites having a low silica content have been mined here for more than 40 years to provide alumina for the production of aluminum and for other purposes. While some of the higher silica bauxite has been mined for chemical purposes, most of it remains in the ground. Although there is no sharp dividing line between low-silica and high-silica bauxite, a few years ago an upper limit of about 5 percent silica was used to distinguish Bayer-process from high-silica bauxite. In recent years, however, material containing more than 7 percent silica has been used as Bayer process feed.

All the alumina produced in the United States at present is made by the Bayer process. There are three operating plants: two run by the Aluminum Co. of America, and one by the Reynolds Metals Co. One Aluminum Co. plant is in Illinois, the other in Alabama; while the Reynolds plant is also in Alabama. The effective operation of these plants depends on a supply of low-silica bauxite, a substantial part of which at present is imported from Dutch Guiana. Since there is a possibility that the flow of Dutch Guiana bauxite may entirely cease, and since there are no known available deposits of bauxite in Canada, Mexico or other accessible foreign countries, it seems advisable to consider the steps necessary for the production of our entire alumina requirements from domestic raw materials. It may also be necessary to export some alumina to Canada.

Next to low-silica bauxite, the best raw material for the production of alumina is high-silica bauxite. Certain high-silica bauxites can be treated by a washing process with a recovery of 60 to 80 percent of the original feed in the form of low-silica bauxite. The ashed bauxite is then treated by the Bayer process. Furthermore, high-silica bauxites can be treated by the Bayer process at an additional cost for chemicals and freight and at an additional cost of processing as a result of lower yields. While there may be a possibility of producing low-silica bauxite from high-silica bauxite by flotation or other beneficiation methods, a special Research Council subcommittee which studied the question did not find the prospect very promising.

One process discussed is a lime-soda sintering treatment for high-silica bauxites. Steps are now being taken to put this process into partial operation at a new Defense Plant Corp. plant in Arkansas which is to be operated by the Aluminum Co. The original scheme was to add limestone and soda to the high-silica bauxite and sinter the mixture, but the procedure has now been changed, and it is planned first to put all the bauxite directly through the Bayer plant. The plant will be run entirely on high-silica bauxite. The average silica content is at present unknown but is estimated to be in the neighborhood of 13 percent. The Bayer process treatment will remove about 70 percent of the contained alumina. The tailings, or red mud, will then be sub-

jected to the lime-soda sintering operation.

The Bayer red mud will contain soda, but will contain little, if any, added lime. It will contain practically all the silica of the original bauxite and a considerable amount of alumina. Lime will be added in the form of pulverized limestone and sufficient soda will be added to bring the mixture to the proper composition for sintering. The sintered product will then be leached and the liquors will be added to the Bayer process liquors. The tailings from this operation will contain very little alumina and the weight of alumina recovered from a ton of high-silica bauxite at this plant should be about comparable to the recovery from a ton of low-silica bauxite when treated by the Bayer process alone. Thus it may be said that substantial amounts of alumina will be produced from the clay in the bauxite processed at this plant.

For the purpose of this discussion, the red mud from the Bayer operation at this plant may be considered as clay. If no red mud were available a certain amount of clay could be treated by the lime-soda process and the liquors could be added to the Bayer process liquors and thus, literally, alumina would be produced from clay. How much clay could be used in proportion to the original bauxite is not now known, but laboratory tests indicate that the amount should be substantial. It will be desirable to find out the maximum amount of red mud, clay or red mud-plus-clay that can be utilized by the combination Bayer-lime-soda process.

BAUXITE RESERVES

Although on the basis of simple arithmetic the combined reserves of low- and high-silica bauxite in the United States would appear to be more than adequate for the present war, including some exportation to Canada, still, to mine all the known bauxite would require vast overburden stripping and many underground mining developments. Furthermore, much of the low-silica bauxite is intermingled with high-silica bauxite. This is a problem that must be studied in detail by experts in order to appraise the various factors.

There can be little doubt, however, about the advantage of operating a plant without the need of separating pockets of low-silica bauxite from the high-silica bauxite. For the most effective use of domestic raw materials for the production of alumina, therefore, it would seem desirable to consider having lime-soda sintering plants constructed at each of the Bayer process plants. At the Illinois plant, in addition to the current production of red mud, there are millions of tons of red mud which has accumulated during the past 30 or more years. The amount of alumina in this red mud is equivalent to that contained in about 1 million tons of bauxite and the alumina is higher in proportion to the silica than in kaolin clay. Lime and soda are also present. To prepare this red mud for the lime-soda sintering operation would require less added lime and soda per pound of alumina than in the treatment of kaolin clay. This red mud is already mined and pulverized. The new soda consumption of this plant would be reduced as a result of the soda recovery from the red mud.

The report therefore suggested that a study be made of the possibility of constructing a lime-soda plant at the Illinois installation to operate in combination with the Bayer equipment. This would enable the plant to use high-silica bauxite and, if more than the current production of red mud could be used in the combination process, the excess could be supplied from the vast accumulation and thus conserve bauxite.

It was also suggested that consideration be given to the construction of a lime-soda sintering plant in Alabama to operate with the Reynolds Bayer plant at that point. High-silica bauxite is easier to obtain than low-silica material at this plant. Hence, if the Reynolds installation is not converted, a supply of low-silica bauxite should be held for it.

Possibly sufficient low-silica bauxite can be obtained in the United States to operate the Aluminum Co.'s Alabama plant. It was suggested, however, that the company be asked to make a study of the possibility of constructing a lime-soda sintering plant, to operate in combination with its Alabama Bayer plant, so that the plant could operate efficiently on high-silica bauxite if necessary.

If all these plants should be equipped to operate on high-silica bauxite they would, at the same time, be equipped to utilize a substantial amount of clay for the production of alumina. This program would appear to offer the best means of conserving domestic bauxite and at the same time offer the best means of utilizing existing alumina equipment in the manufacture of alumina from clay. It should be made clear, however, that the changing of a Bayer plant to a combination Bayer-lime-soda plant involves much more than the mere addition of a set of kilns. The use of high-silica bauxite will result in an increased amount of red mud, and the lower lime content may increase filtering difficulties. Among other things, additional mud-handling equipment will be needed, and means must be provided for controlling the moisture content of the mud, for incorporating the lime and soda, for proportioning the kiln feed and controlling the liquors. Although the conversion of a Bayer plant approaches a major operation, no other program seems so promising.

CLAY PROCESSES

From the information now available, it would appear that the lime-soda sintering process can be used effectively on kaolin only in conjunction with a Bayer plant. There should be one or more processes ready for operation for the production of alumina from clay in which there is no dependence on a Bayer plant. The committee gave consideration to this matter and felt that a modified Pedersen process offered the greatest promise for such a process. In skeleton form, this process consists in sintering the clay with lime and subsequently leaching with soda. There are many variations to be studied, not only in the sintering and leaching, but in the treatment of the liquors as well. Results of many laboratory experiments, both in the United States and abroad, give promise that the process will be operable, but it will be desirable to carry out additional work on a test plant basis to obtain data for the construction of a production unit.

In order to gain this needed information as soon as possible, the committee recommended that the War Production Board allocate up to a maximum of $100,000 to the War Metallurgy Committee for the installation of equipment for a test plant, and for its operation. It was ascertained that the Eastern Experiment Station of the U. S. Bureau of Mines at College Park, Md., would probably have space for the test plant and it was suggested that the test plant be located there, if suitable arrangements could be made. It was also recommended, that the War Production Board assist in the procurement of equipment for this test plant. If the results should be as expected it would be possible in the future to use clay in producing alumina of a suitable grade for the manufacture of aluminum, without the use of acids. This is a goal much to be desired. The construction and operation of a

plant requiring no acids offer many advantages over plants in which acids are required.

The Eastern Experiment Station of the Bureau of Mines is already working on the lime-soda sintering of clay. Work on the modified Pedersen process should be in addition to the other work on alumina at the Experiment Station.

Although the committee prefers the alkaline process in the treatment of high-silica bauxite, red mud or clay, it believes that an acid process is preferable in the treatment of alunite. Kalunite, Inc., is proceeding with a plant for the production of alumina from alunite. The committee suggested that the completion of the first unit be speeded as much as possible so that practical experience can be gained with a minimum loss of time. The Kalunite plant probably can treat 2–3 tons of clay for each ton of alunite without using more sulphuric acid than can be obtained from the sulphur in the alunite.

Kalunite, Inc., also has a pilot plant in Utah, funds for the operation of which were supplied by the Defense Plant Corp. on recommendation of the War Production Board. The report recommended that the War Metallurgy Committee be given the responsibility for the operation of this pilot plant to facilitate coordination of the alumina experimental program.

The committee believes that the Kalunite process, or other processes dependent on the utilization of potassium alum, are the best available acid processes for the production of alumina. The Morenci tailings project, work on which is being sponsored by the Defense Plant Corp. through the War Metallurgy Committee, comes within the classification of a potash alum process.

Another acid process is one which is being worked on in the pilot plant stage by the Tennessee Valley Authority at Wilson Dam, Ala. In the earlier stages of the operation, according to the report, the alumina produced was not nearly pure enough for the manufacture of aluminum. The committee made various suggestions for improving the grade of material produced, but results achieved by these suggestions were not available at the time the report was prepared.

The report noted the fact that the Aluminum Co. now has a pilot plant for investigating the lime-soda sintering process to gain the necessary data for the design and operation of the new Arkansas alumina plant. The committee considered it advisable that pilot plant work be speeded on the treatment of clay and therefore recommended that the Aluminum Co. be urged to install an additional pilot plant leaching unit for this purpose, if the equipment is obtainable, and suggested that the War Production Board provide assistance. Possibly an even better plan would be to use an available kiln and building at the Aluminum Co.'s Illinois plant, adding to it the equipment needed for a red-mud treating pilot plant. The plant could be in operation soon, after which the company's smaller pilot plant could be turned over to the study of clay.

In conclusion, the report recommended means for the conservation of bauxite. Most alumina abrasives require substantial amounts of special low-silica bauxite and it may be desirable to earmark the necessary quantities of such domestic material for the production of such abrasives as are essential for the war effort. Furthermore, most aluminum sulphate made in the United States is made from bauxite, but one company at least is making this product from calcined clay. Since large quantities of bauxite could be conserved by restricting its use in alum making, the committee suggested that this matter be considered.

As a final proposal, it was suggested that prospecting for new domestic deposits be carried out vigorously, since a few million dollars spent so would doubtless save tens of millions in the long run.

Guinea Pigs For Tank Cars

To determine which chemicals can be carried efficiently in aluminum tank cars, the Aluminum Company of America is employing an adaptation of the traditional laboratory "guinea pig." Developed by A. H. Woollen of the Development Division in New Kensington, Pa., the guinea pigs are neat-looking aluminum cans, about the size of that humidor on your smoking table. Insofar as the proportion of different metals in these containers is concerned, it is the same as an 8,000-gal. tank car built of 17S-T alclad plates, with 17S-T rivets and anchor backup plates.

The small piece of 17S-T sheet riveted to the inside wall of the container is applied with aluminum rivets, and represents the edge of the alclad plates which are exposed to the chemicals carried inside a tank car. The three rivets attaching this piece to the side of the container, as well as the three rivets on the opposite side, are exactly proportionate in area to the rivet heads exposed to the lading in the full-sized tank. The small round disk of 17S-T plate attached by a rivet to the bottom represents the plates which are used in the bottom of the tank car to back up the anchor rivets. Of course, the rivets in the center of this disk are proportionate to the real exposed area for the anchor rivet heads.

Similar cans have been made using 3S alloy, 52S alloy, 53S, and 61S. By placing chemicals in these containers accurate answers are obtainable in a relatively short time as to whether the chemical will corrode aluminum, or the aluminum will contaminate the chemical. Nitric acid, for example, makes a slight attack on aluminum containers, but this attack is so small that it would take about 30 years to decrease the cross-section of standard aluminum plates to a material degree. Furthermore, the product of the corrosive attack by nitric acid does not contaminate the liquid. It is therefore considered entirely safe to ship the acid in aluminum tank cars.

Through the use of these same guinea pigs, the satisfactory performance of aluminum alloys for I.C.C., 42B drums, barrels, and other containers has been established.

Proportions of various alloys in this "guinea pig" simulate a tank car or other container for corrosion tests

Preventing Heavy Metal Poisoning in Industrial Operations

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Chem. & Met. INTERPRETATION

Last month the author dealt with the general problems that chemical engineers encounter in combating chronic poisoning in chemical operations. Herein he deals with the causes, symptoms and prevention of heavy metal poisoning, as exemplified by lead. Future articles will treat specifically of fibrosis-producing dusts and toxic solvents and with methods of combating hazards from these.—*Editors.*

ALL OCCUPATIONAL diseases are not caused by poisons. For example, the fibrotic condition of the lungs, caused by silica and asbestos, could not be considered poisoning. In a similar manner, the allergic reaction of certain people to pollen cannot be called true poisoning. However, some of the metals and their salts, such as lead, cadmium, antimony, arsenic, manganese and selenium are true poisons. Their action, quite definite and not limited to a few susceptible individuals, varies. However, the means of entry to the body is similar and the toxicity is of the same order.

Since it would be impossible to discuss all these materials in detail, this paper is limited to a discussion of lead as a typical metal poison. More is known about this metal than the other materials of this group because of its very wide industrial use over a long period of time.

LEAD COLIC

Lead poisoning may occur as colic, arthralgia, palsy, or encephalopathy. The fact that the symptoms of lead poisoning may appear either in the stomach, in the joints, as paralysis, or in the brain, indicates the difficulty of identifying it as the cause of illness. It is so similar to many other complaints that its effects are sometimes masked by another disease. The diagnosis of lead poisoning can be fairly well established by a history of lead exposure, blood examination, urine examination, the existence of the lead line, and colic or other symptoms mentioned.

Symptoms of colic include a severe pain in the abdomen, which may cause the patient to double up or fall to the ground. This attack may come without warning but is generally preceded by gastric discomfort, lack of appetite, constipation and nausea. Old-time smelter men feel that if constipation can be avoided, they will never have lead colic. This form may be the first sign of lead absorption and it increases in intensity after a day or two. It is an indication that poisoning is occurring and that steps should be taken to eliminate the entry of lead into the body.

That the patient appears to be recovered from an attack does not mean that he is cured, since it is possible that lead is being stored in his bones, which will decrease the lead actually circulating in the blood stream. This stored lead is harmless as long as it stays in this inactive state. The serious symptoms of lead poisoning occur as a result of the lead circulating in the blood. This may be increased by a discharge of lead from the bones when the worker is run down and cause serious lead symptoms at a time when the patient is least able to fight it.

Amount of circulating lead is determined by the amount of lead entering the body and also by just what is happening to the stored lead. For example, if considerable lead is being absorbed but is being stored in the bones as rapidly as it enters the body, then the symptoms will not be too severe. If the exposure has been reduced and the lead entering the body is quite small but lead is leaving the bones from a previous exposure, a person may develop a severe case of lead poisoning with little or no exposure.

It has been said that lead follows calcium. For this reason, a high calcium intake with the use of milk is often used to relieve serious lead symptoms. However, lead which may still be stored up in the bones is potential dynamite. Very possibly this stored lead may never cause any damage, but the trouble which it might cause is so serious that everything possible should be done to avoid this condition. Hence, it is not desirable to depend on the use of milk and a high calcium intake to prevent lead poisoning: everything possible should be done to keep down the lead exposures as much as practical. A bottle of milk a day is not a substitute for an exhaust system.

ARTHRALGIA AND PALSY

Lead workers may complain of muscular cramps and pains in the large joints. The pain may be as severe as in the case of lead colic but often is of short duration. It usually occurs as one of the symptoms of lead poisoning but not as the only one. The description of these joint pains generally occurs in the case history after several attacks of colic.

Palsy generally occurs after several attacks of colic and long exposure to lead. The condition affects those muscles most used. Painters, for example, will be affected in the wrists and fingers of which the condition known as "wrist drop" is a fairly common example. The hand hangs down when the arm is extended nor is it possible for the man to bend his hand back even though there is force left in the hand itself except for the flexing back of the wrist. When this condition occurs, the exposure has gone on for some time and lead poisoning is fairly well advanced. It is an indication that considerable lead is circulating in the blood stream and affecting the various parts of the body.

Encephalopathy is the type of lead

poisoning that involves the brain. The symptoms are mental confusion, delirium, hallucinations and faulty speech. Death may result from apoplexy during delirium. Blindness and loss of color perception have also been reported. After the violent mental signs have disappeared, the patient may be sluggish mentally. The symptoms described are alarming and leave no doubt that everything possible should be done to control the hazards.

OCCURRENCE OF HAZARDS

It is, of course, important to know where to look for lead poisoning and how to identify exposure in potentially dangerous occupations. Although lead is generally considered an occupational hazard, it is interesting that nearly 60 percent of the cases reported in a recent survey were non-occupational. This particular survey indicated a number of cases resulting from the use of storage battery casings for fuel. Another large group were children who acquired lead poisoning by chewing objects painted with lead pigment.

Use of lead is widespread and consequently the operations where lead poisoning occurs are also numerous. It appears that, at the present, the more serious forms of lead poisoning occur in occupations where apparently no exposure exists. A typical example of this was an epidemic of lead poisoning resulting from the use of lead-coated nails by shinglers. These men held the nails in their mouths and, in this way, absorbed the lead. The symptoms which were complained of were severe muscular pains in the forearm and calf of the leg. There was also a dead and numb feeling, similar to paralysis. Cramps and abdominal pains were also present. If the manufacturer of the nails had given consideration to this practice of the shinglers, the product would not have been put on the market. Also, if the men had realized that the nails were coated with lead, they would not have exposed themselves to the hazard.

Operations where lead poisoning may exist are too numerous to list, but Table I indicates some of the more common occupations where there is a definite lead exposure.

LEAD DETECTION

In determining the extent of the hazards in any of these potentially dangerous industries or others which may be suspected, an accurate determination should be made of lead in the air. The sample which is to be analyzed may be taken by the Greenburg Smith impinger for lead dust and collected with an electric precipitator for fumes. Descriptions of the sampling methods and the analysis are given by Jacobs.[1]

Table I—Some Common Occupations Having Definite Lead Hazards

Painters
Red lead workers
Storage battery makers
Printers
Insecticide makers
Lead burners
Glaze dippers
White lead workers
Putty makers

Some work has been done in this laboratory using a respirator with replaceable filter as a sampling device. An approved type respirator is worn for a day or two. The replaceable filters are then removed and their lead content determined. The value is converted to milligrams of lead per day, equivalent to milligrams per 10 cubic meters used for impinger samples.

This method gives the entire exposure as compared to only the exposure during the sampling period given by the impinger. Operations may vary so that the average exposure may differ widely from that indicated by an impinger or precipitator sample. This method has value as an economical means of checking atmospheric contamination in plants which do not have enough work to warrant the investment in an impinger or precipitator.

In the case of (2), the worker did a job of dismantling some old duct work which was not picked up by the impinger as the work was not carried on during the sampling period. In the case of (4), the correct

Table II—Comparison of Impinger and Respirator as Sampling Instruments for Lead

Operation	Respirator mg/day	Impinger mg/10 cubic meters
(1) Lead burning.....	7	6
(2) Repair work in lead plant	65	5
(3) Repair work in lead plant	4	4
(4) Putty manufacturing	3	12
(5) Sweeping	10	15

Milligrams per day = Milligrams per 10 cubic meters.

weighting was not given to the intermittent nature of the work. The impinger sample was taken during a period of high concentration, and this was not representative of true conditions. Although the results do not check with those of the impinger, it is felt that they represent the actual conditions at the time of exposure, which is most important.

It is generally considered that if the air contains lead in excess of two milligrams per 10 cubic meters of air, which represents a day's exposure, there is definite danger of lead poisoning. Of course, if the lead concentration is below this amount, it is still necessary to give the utmost care to sanitation regarding drinking water, washing facilities, proper type of lunch rooms and every type of precaution to prevent ingestion. The fact that the lead in the air is within a safe limit does not eliminate the hazard from ingestion through carelessness by the employees.

DANGER FROM FUMES

One of the more common types of lead exposure which occurs in several of the occupations named is the production of fumes from the melting of lead. When this metal is melted and exposed to the air, there is a scum of lead oxide formed on the surface which may get into the air by air currents or by mechanical agitation of the surface. Calculation of the vapor pressure of lead indicates that theoretically, no injurious concentration would be given off below 900 deg. F. We have found, however, that if there is considerable mechanical agitation, such as exists in certain dipping or pouring operations, the concentrations of lead may be 100 times that which would otherwise be expected at the same temperature.

The proper respiratory protection from the fine lead oxide which results from the heated metal is a lead fume respirator of the mechanical filter type. Masks depending on charcoal are useless, as the fumes are not a gas but are extremely fine particular matter.

It is desirable to detect signs of lead absorption before this condition develops into serious poisoning. It is possible to get an indication of possible absorption by an examination of the blood of workers. If this examination is conducted at regular intervals, it will serve as a check on the engineering control methods and also on the care taken by the workers to prevent the entry of lead into the body. Absorption results in an increase in the number of basophilic cells. This condition may not be specific, but it does offer a fairly simple method of checking on changes in the circulating blood. Another method which has been suggested for checking on incipient lead

poisoning is the determination of lead in the urine by use of the polarograph.

METHODS OF CONTROL

Steps in dealing with control of lead poisoning are as follows:

1. Determine chemically the amount of lead in the air if there is any question of exposure.

2. Reduce the lead content in the air by means of exhaust equipment to the lowest practical point. This can be done by enclosing the dust producer and exhausting so that a slight negative pressure is maintained. Local exhaust hoods are preferred to general ventilation.

3. If there is any question about the efficiency of the exhaust equipment, protective equipment such as respirators approved by the Bureau of Mines should be furnished. In the case of metallizing employing lead, a positive pressure helmet should be used.

4. Hazardous operations should be isolated so as to expose as few employees as possible.

5. The employer should see that the men wear suitable clothing, such as overalls and jumpers. These should be thoroughly washed at least weekly. The employer should provide a suitable place for the men to change their clothes.

6. Sanitary drinking fountains should be used and no other supply of water should be permitted in work rooms where any lead process is in operation.

7. The employer should provide suitably heated and lighted wash rooms, separate from the work or eating rooms. These wash rooms should be provided with running hot and cold water and be adequate for the number of employees.

8. Shower baths should be provided with running hot and cold water. The employer should provide a sufficient supply of soap, bath towels, and hand towels for each employee.

9. The employer should require each man to wash his hands and face before eating lunch and at the close of the day's work.

10. Men should be required to take a shower bath before leaving the plant.

11. A suitable place must be provided for the employees to leave their lunches. No one should be allowed to eat in any room where lead operations are being carried on. It has been found that special lunch rooms, equipped with suitable tables and benches, are an excellent method of control.

12. Use of tobacco in any form should be prohibited during working hours due to the possibility of the tobacco becoming contaminated with lead dust or fumes.

13. Sweeping, if done at all, should be performed wet and at the end of the shift.

14. Wherever possible, cleaning operations should be by vacuum system. Floors and walls should be so constructed that there would be little accumulation of dust and dirt. Rafters and beams which might catch suspended materials should be cut down as far as possible. In some plants triangular pieces of metal are placed on the rafters so that dust will not be retained.

15. Periodic physical examinations, together with blood tests, should be made to check on the efficiency of the control methods.

This list of control measures is not complete, but it does indicate the consideration which has been given to the problem. It is the result of long experience acquired by the lead industry. It is because of control measures such as these that the number of lead poisonnig cases in occupations which are known to be definitely hazardous have been nearly eliminated. Although at the present time stress is being placed on control of lead dust, the importance of personal cleanliness and the limitation of ingestion cannot be overemphasized.

The purpose of this article is not to emphasize the hazards of lead but to point out that it can be used with safety if certain of its properties are recognized.

If the question of chronic lead poisoning arise, it is desirable to contact those authorities who have knowledge regarding these hazards. The State Department of Industrial Hygiene, or in some states the State Labor Department, the National Safety Council or representatives of insurance companies all have considerable information regarding toxic limits and the control of hazards. These agencies are glad to cooperate in any way toward furnishing information or making studies. Such information and services are available without charge to practically any plant.

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Torch cutting of metal which has been coated with lead paint has frequently resulted in cases of acute lead poisoning. Lead fume respirators should always be used in such hazardous operations

Managing New Product Development in Chemical Industry—II

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Chem. & Met. INTERPRETATION

Last month the author introduced the subject of management of new product development in the chemical industry by discussing the problems, technique and management of the research stage, including sources of ideas, preliminary screening of ideas and initial technical-economic investigations. In this concluding article the problems connected with the pilot plant, semi-commercial plant and transfer to full scale production are all discussed.—*Editors.*

THERE is a fairly sharp dividing line between the research and the development stages of a new chemical product. In the former, the general object is to find out if the product can be made and if it should be made, while in the development stage an effort is made to work out a satisfactory commercial process and to prepare for full-scale marketing.

Technical development takes the form of making the product in small-scale production units. The words "pilot plant" and "semi-commercial plant" are sometimes used synonomously. In this article the distinction is made that the product from the pilot plant is not sold to the market, while a part of the output of the semi-commercial plant is sold on a small scale.

PILOT PLANT

The pilot plant is a small-scale production unit set up for the following purposes:

1. To determine if the laboratory process for making the chemical will work on a larger scale in industrial equipment.
2. To raise yields, improve quality and lower costs by refining the process. Pilot plants are frequently used for this purpose by the production departments of chemical firms to improve *present* full-scale operations. However, the pilot plant discussed here is understood to be one used in the development of new products.
3. To gather engineering data for use in designing the full-scale plant.
4. To make a sufficient quantity of the product for testing and distributing as samples.
5. To obtain more accurate estimates of manufacturing costs.
6. To train personnel for operating the full-scale plant.

There is usually a change of personnel when the product is transferred from the laboratory to the pilot plant. Chemical engineers often form an integral part of the group operating and observing pilot plant operations. However, in many companies the pilot plant group is headed by the research chemist previously in charge of the laboratory research, since he is most familiar with all of the details of the process. The study of the product and process by chemical engineers constitutes an evaluation from a different point of view than that of the research chemists. Many executives emphasize the importance of the pilot plant for this reason.

The semi-commercial plant, larger than the pilot plant, has as its primary purpose the production of sufficient quantities of the new chemical to permit sales in small lots. However, the semi-commercial plant is still experimental, and its purposes also include all those listed under the pilot plant.

SEMI-COMMERCIAL PLANT

A distinction is sometimes made between new chemicals already made by competitors and those which are entirely new and must be introduced to the market. For the former, a pilot plant just large enough for experimental purposes is used. For entirely new products, a semi-commercial plant is designed larger than necessary for a purely experimental pilot plant and yet large enough to permit fairly economical production so that the product can be sold at the cost of manufacture. This permits the company to "break even" on the costs of operation.

Data for the design of the semi-commercial plant are gathered in the laboratory. The size of the semi-commercial plant is estimated by the director of development, who has previously conducted market surveys and customer tests. The output is introduced to the market by a staff of market development men who specialize in such work. The price is naturally higher than that ultimately possible, but it is low enough to permit limited sales to users who have the greatest need for it. As the demand grows, the semi-commercial plant is operated at an increasing percent of its capacity. When full capacity is reached, preparations are made to transfer the product to a large, full-scale plant.

MARKET DEVELOPMENT

Desirability of using a semi-commercial plant after, or in place of, a pilot plant depends on many factors, including the economics of production costs, possibilities of getting necessary design data in the laboratory, and importance of introducing the new chemical to the market.

Market development, the preliminary introduction of new chemicals to the trade, is another activity carried on during the development stage. It is closely associated with evaluation of new products by customers and with application studies. Such work is carried on by different staffs in different companies: by salesemen, by sales service men, or by special market development staffs attached either to the sales or to the research department.

The use of specialized market development men in chemical companies seems to be increasing. These men are technically trained and industrially experienced. They do most of their work in the field, talking with customers' research and production men. They are usually responsible for handling new products from the time of chemical development

until they are turned over to the regular salesmen for full-scale marketing. In essence, they do "experimental marketing." Their job is to "educate" customers, to adapt new products to customer needs, and to uncover uses for new products. In one company, there is a staff of five market development men, each of whom specializes in one customer industry and handles all new products intended for use in that industry.

Exact organizational set-up and functions performed by market development staffs vary considerably, but there is a recognized need for a specialized group with the patience and technical knowledge of the research men plus the sales ability of the salesmen.

CUSTOMER EVALUATION

Customer evaluation is the process of testing and evaluating new chemical products by potential customers or in customers' plants. The conduct of this seems to be a very controversial and perplexing question in the chemical industry. Practice varies from avoiding it as much as possible until the product is placed on the market to distributing samples while the product is still in the laboratory stage. The following are objections to customer evaluation expressed by executives:

1. Samples of new chemicals are a nuisance to customers, who may feel that they are being asked to do research for the distributing company.
2. The customer may decide that the product is excellent and that he would like to purchase quantities of it, only to find it not yet available in commercial lots.
3. The customer may get a bad impression of the new chemical while it is still in the experimental stage and retain that prejudice even after it has been improved.
4. Patent protection of the manufacturing process and product uses may not be complete.
5. If the product is given only to a few companies, this constitutes discrimination in favor of those concerns, which may bring repercussions later.

On the other hand, there are important reasons and advantages for customer evaluation:

1. It constitutes an evaluation of the product by the ultimate user, who is expected to buy it in large quantities later.
2. Difficulties and "bugs" not foreseen in research and development studies are brought to light.
3. Information for improvements necessary or desirable before the product is placed on the market is developed.
4. Information for establishing different grades of products can be obtained.
5. Data are usually provided for a check on market surveys.

Because of these advantages, chemical companies have sought ways to secure customer evaluation without the disadvantages. Three general methods have been tried:

1. Evaluation within the producing company from the point of view of the customer is being used as far as possible by many concerns. This is accomplished by specialized application laboratories and by market development men and sales engineers well acquainted with the needs and desires of customer industries.

2. Cultivating a few friendly customers who will be glad to cooperate is actually only a modification of the original concept of customer evaluation. By careful selection and cultivation of a few customers, many of the disadvantages may be minimized. The cultivation may include adhering to careful policies on distributing samples, offering the customer something in return, having men from the producing company conduct the tests in the customer's plant, or purchasing an interest in the customer concern.

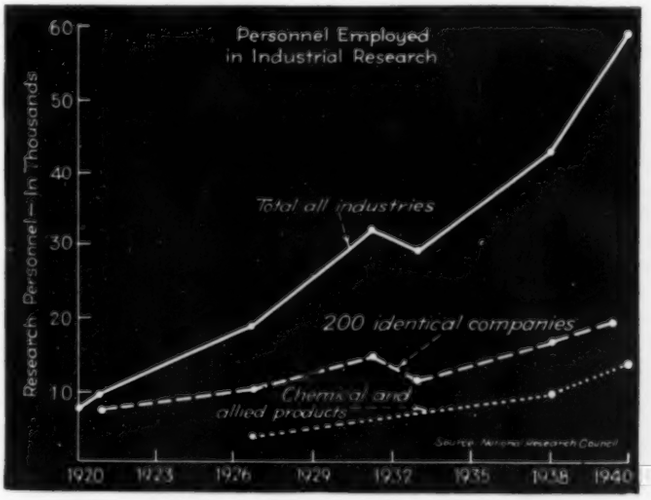
3. Some companies submit a sample to chemical consultants, asking them to determine if it is applicable to particular "customer" industries. The experience of chemical consultants with chemical *consuming* industries is valuable in making such evaluations.

An interesting problem that arises in application research is determining how many uses should be studied, developed, and patented before the new chemical is released generally to the market. By continuing research and application study many of these possible uses may be investigated, but this takes time and delays the introduction to the market. On the other hand, the developer will suffer if other companies should investigate and patent uses for the chemical. The patent department naturally wants all possible uses explored before the product is placed on the market. The usual practice is to investigate and patent only the most important uses before the product is announced.

While the new product is in the pilot plant, studies of other economic factors are continued so that these are completely understood by the time the product is transferred to semicommercial or full-scale production. Estimates of the cost of manufacture are further refined, checked by development men and sometimes by cost accountants. The raw materials situation is scrutinized thoroughly, data being gathered on prices, quantities available, locations of important suppliers, transportation costs, and other factors.

Specifications for containers are carefully checked to make sure they are adequate for shipping large quantities of the commercial commodity. The problem of pricing is ironed out at this stage. This is extraordinarily complicated, for the selling price must be related to the cost of manufacture, competitive prices, geographical distribution of customers, quantities purchased, cost of marketing, amounts which will be purchased at various prices, and many other factors. Executives from several departments of the company frequently cooperate in the task of setting prices. One common practice is to inform the customer that the price of the new product will be lowered later when the demand increases.

A financial appraisal is usually made just before the transfer from the pilot plant to full-scale produc-



tion, or before a semi-commercial plant is built. This appraisal is usually comprehensive because of the considerable investment in equipment that is necessary. In one company, a complete report on each project must be submitted to a budget committee before a product can be transferred from the pilot plant to full-scale production.

FULL-SCALE OPERATIONS

Final stage in the development of a new chemical product is the transfer to full-scale operations. This includes design, construction, and preliminary operation of a full-scale plant and transfer to full-scale marketing.

Detailed design and construction of the plant is usually handled by a separate design or mechanical engineering department, although much of the data may have been gathered by the chemical engineers working on the pilot plant. For radically new products made by complicated processes, design and construction require a great deal of time and effort; while for other products which are similar to those previously produced by the company, such activities may consist only of adapting present equipment to the manufacture of the new product. If the development is "big" enough to require a separate plant, then all factors of plant location have to be considered before construction is undertaken.

A compromise must sometimes be made between the size of plant required for optimum production costs and the size dictated by the probable market demand. The most economical plant, production-wise, will often have a larger capacity than the present market demands. This may result in the construction of a large but economical plant with the hope that demand will increase sufficiently to permit operation at a reasonable percent of capacity.

After the plant has been constructed, there follows a period of preliminary operation during which members of the research and development staff are present to study and remedy any problems that arise. In one company, a radically new product was recently developed and the management felt that the plant should be located within a reasonable distance of the research laboratories so that the research personnel would be available to study and remedy all difficulties.

Operators are often trained for the full-scale plant by having them operate the pilot plant. In one company, the pilot plant is operated by a selected group of regular production workers who thus become familiar with the production technique on a small scale. Usually a few of these "payroll" workers will stand out as being most adept, and one of them is selected as foreman of the full-scale plant.

On the marketing side, a transfer is made from the market development men to the regular salesmen in those companies which have specialized market development staffs. If the technical characteristics of the product are important, this involves training the salesmen and a gradual transfer from special, "experimental" marketing to a more extensive selling program.

Transfer of the product from experimental operations to full-scale production and marketing present many problems of coordination, cooperation, and balance. Various methods which are used by chemical companies to accomplish a smooth transfer include: (1) use of market development staffs for experimental marketing, (2) use of a semi-commercial plant between pilot plant and full-scale production, and (3) use of special liaison officers to coordinate the efforts of research, production, and sales.

GENERAL MANAGEMENT

Evaluation of monetary returns from the research and development program are very difficult, primarily because results cannot be measured accurately in dollars and cents. Executives have indicated that this difficulty lies in the fact that in each new development contributions are made by the sales, production, legal, and financial staffs as well as by the research and development departments. In most companies arrangements are made to charge research expenses to specific projects, and to compare the sales and profits on new products to the expenses incurred during research and development. However, most executives feel that these figures do not tell the whole story. A sound evaluation of the results of research can be made only in a qualitative way by pointing out the importance in the company's activities of new products contributed by research and development.

Executives emphasized the importance of "knowing when to stop," of being able to recognize "dead-end" projects. It is difficult to foresee what may be discovered "just around the corner" if research work should be continued. Usually research and development workers want to continue work on new projects, feeling that the obstacles encountered will be overcome by more research; but research executives must exercise restraint to keep from "throwing good money after bad" by continuing projects which will never be productive. Various techniques have been used to assist in making decisions on whether or not to continue a given project. Many companies apportion funds to projects in such a way that when one allotment has been spent, then the whole project must be reviewed.

TIME FACTOR

The time necessary to develop a new chemical commodity varies considerably from product to product. Most executives agree that for a basically new chemical, from seven to twelve years are required for complete development. For products similar to those already being made by the company, this time is considerably shorter.

Executives of one concern have found that for new chemicals quite similar to present ones, only about a year for complete development is sometimes necessary. In another company, one new chemical was developed within two weeks from the time the sales department reported a demand to the time drums were being shipped to the customer.

The relatively long periods of time required for development present quite a challenge to aggressive management in the chemical industry. Most executives admit that they are continually trying to find short-cuts. Many managerial methods discussed previously are intended to shorten this development period. Among those specifically mentioned were:

1. Conducting "high-spot" studies to find crucial factors, then completely investigating these factors.
2. Making market surveys before projects are undertaken.
3. Providing a staff of market development men to introduce new products to the trade.
4. Not adhering to any standard procedure in development, but in each specific case selecting only those steps absolutely necessary.
5. "Promoting" each project by bringing it to the attention of the proper executives at the right time.

One company has an assistant to the president who acts as a liaison officer and whose duties include the "promotion" of new developments. As that officer expressed it, "The time it takes to develop a new product is an inverse function of the 'oomph' behind it."

Timesaving Ideas for Engineers

NOMOGRAPH FOR QUICK SOLUTION OF EFFICIENCY EQUATIONS OF ELECTROLYTIC ALKALI AND CHLORINE CELLS

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CHEM & MET PLANT NOTEBOOK

MANY different types of electrolytic caustic and chlorine cells are now in commercial operation, but in order to analyze each cell critically several efficiencies must be calculated. These calculations, although relatively simple, may require considerable review work by the engineer who has not been called upon to make such calculations for several years. Also the engineer who is familiar with electrolytic cell operation will spend considerable time in calculating these efficiencies, and often in certain cases the engineer must calculate the efficiencies of a number of cells each day.

Probably no series of equations offer themselves more adaptably to nomographic or alignment chart solution than do the electrolytic alkali cell calculations. Very important in the economics involved in cell operation characteristics are these three efficiencies—percent current efficiency, percent voltage efficiency, and percent energy or power efficiency. For the executive who wants something concrete and realistic, the energy efficiency is expressed in a different way, that is, kilowatt-hours of electricity required to produce 1 lb. of NaOH, which may readily be converted from units of caustic to units of chlorine or hydrogen produced, or the NaCl decomposed.

According to Faraday's Law, one of the most exact laws known, one Faraday or 96,480 coulombs will deposit, liberate, or is equivalent to 1 gram equivalent of any substance at each electrode. Since 1 coulomb is defined as the quantity of electricity passing when 1 ampere flows for 1 second, it is pos-

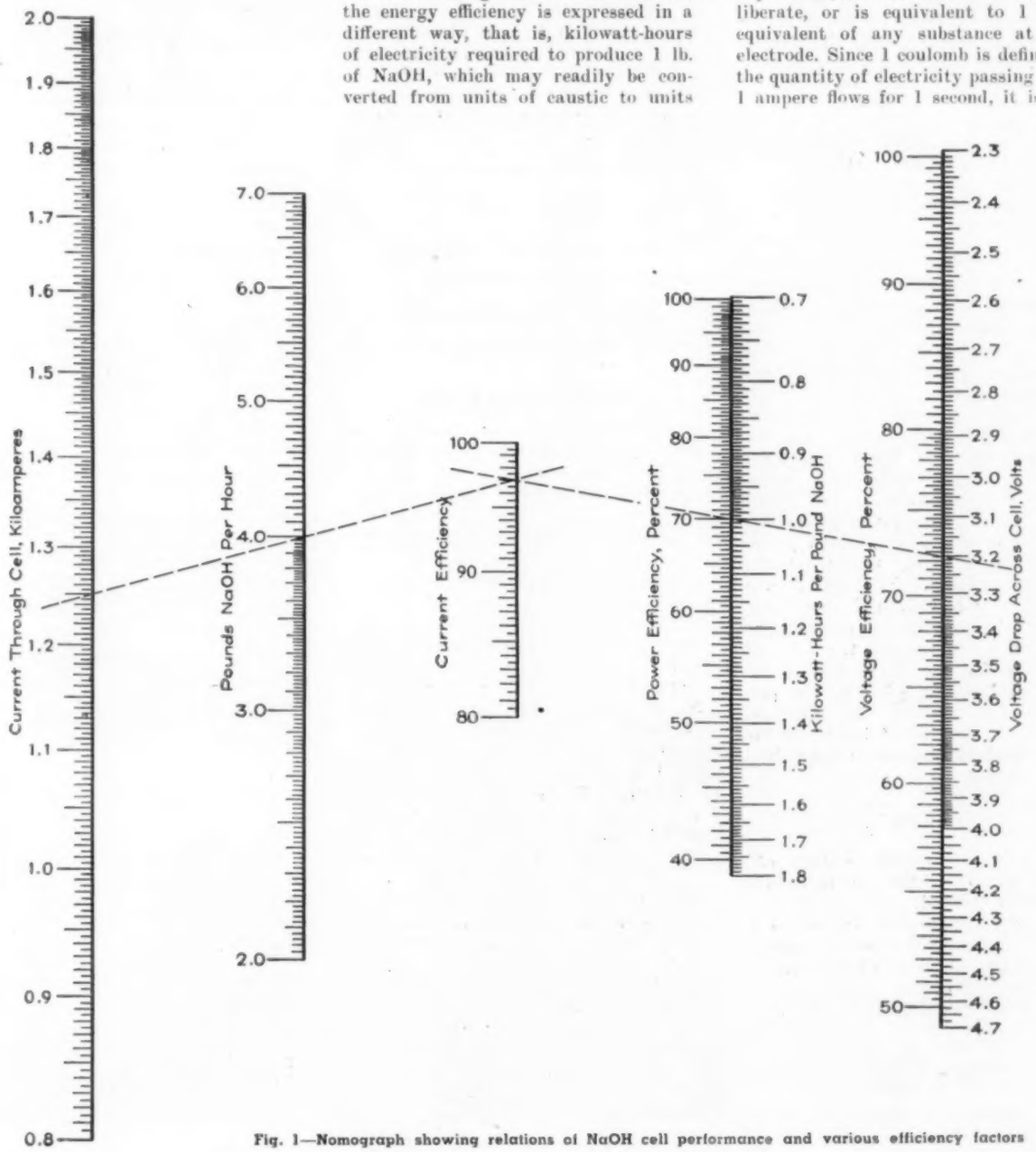


Fig. 1—Nomograph showing relations of NaOH cell performance and various efficiency factors

Fig. 2—Chemical equivalent diagram relating NaCl decomposed with NaOH, chlorine and hydrogen produced

sible to calculate the theoretical quantity of NaOH that should be formed when a specific quantity of electricity is passed through the cell. Because of certain definite and numerous reasons that will not be discussed here, it is found in commercial practice that the actual weight of caustic made is always less than the theoretical quantity as calculated from the quantity of electricity passed through the cell. By definition then, the percent current efficiency is defined as the product of 100 times the ratio of the pounds of NaOH actually made per hour, to the theoretical weight of NaOH that is equivalent to the quantity of electricity passed through the cell. Then

$$(Ce) = 100 \frac{L}{\frac{(A)\ (3{,}600)}{(96{,}480)} \frac{(40.005)}{(453.6)}} = 3.039 \frac{L}{(Ka)}$$

where (Ce) = percent current efficiency; L = pounds of NaOH actually made per hour; A = amperes passing through the cell; and (Ka) = Kiloamperes = $A \div 1{,}000$.

Many investigators have attempted to calculate by the Gibbs-Helmholtz equation and prove the absolute minimum voltage potential needed to decompose NaCl in solution into its component elements. Many factors enter into this derivation and consequently some discrepancy was found among the various investigators for the value of this decomposition potential. Suffice it to say that the maximum discrepancy, fortunately, was only about 0.1 volt, and that after considerable investigation and thought many companies accepted the value of 2.31 volts for the decomposition potential of NaCl in solution. The percent voltage efficiency is, therefore, equal to the product of 100 times the ratio of 2.31 to the actual voltage drop across the cell, or

$$(Ve) = 100 \frac{2.31}{V}$$

where (Ve) = percent voltage efficiency; and V = the actual voltage drop across the cell.

Knowing the percent current and voltage efficiency, the percent energy efficiency (Pe) of the cell is found to be the product of the percent current efficiency and percent voltage efficiency divided by 100, or

$$(Pe) = \frac{(Ce)\ (Ve)}{100}$$

The number of kilowatt-hours of electricity needed to make 1 lb. of NaOH is found by the following:

$$E = 2.31 \frac{\frac{(453.6)}{(40.005)}\ (96{,}480)}{(3{,}600)\ (1{,}000)\ \frac{(Pe)}{(100)}}$$

or $E = \dfrac{70.195}{(Pe)}$

where (Pe) = percent energy efficiency; and E = kilowatt-hours per pound of NaOH produced. These relations appear in the nomographic chart, Fig. 1.

The horizontal lines of Fig. 2 give the chemical equivalents of caustic, or in other words they give the quantity of chlorine and hydrogen made and the quantity of NaCl decomposed when a specified quantity of NaOH (L) is formed, thus

Pounds of chlorine made per hour =

$$\frac{35.455}{40.005} L = 0.8863\ L$$

Pounds of hydrogen made per hour =

$$\frac{1.008}{40.005} L = 0.0252\ L$$

Pounds of NaCl decomposed per hour =

$$\frac{58.452}{40.005} L = 1.4611\ L$$

TYPICAL CALCULATIONS

Quantitative tests were made on an electrolytic alkali cell and the following data obtained:

Amperage = 1,250 amp. (1.25 kiloamp.)

Voltage drop across cell = 3.2 volts

Weight of NaOH made per hour = 4.0 lb.

From these data obtain the percent current, voltage, and energy efficiencies of the cell, and the number of kilowatt-hours of electricity used per pound of NaOH produced. Also find the number of pounds of chlorine and hydrogen made and the number of pounds of NaCl decomposed.

Solution—Connect 1.25 on the Kiloampere scale with 4.0 on the Pounds-NaOH-per-Hour scale, extending the line to the Current Efficiency scale and read 97 percent current efficiency. Then connect 97 on the Current-Efficiency scale with 3.2 on the Voltage scale, the intersection on the Power-Efficiency scale being 70 percent, which corresponds to 1 kw-hr. per pound of NaOH, as found on the scale adjacent to the Power-Efficiency scale. The percent voltage efficiency is found on the scale adjacent to the Voltage scale, and for a voltage drop of 3.2 it is found to be 70 percent.

To find the equivalent for 4.0 lb. of caustic per hour, a vertical line is drawn through the 4.0 on the NaOH top horizontal scale of Fig. 2 and extended to intersect the lower horizontal scales. Reading the various scales we find that when 4.0 lb. of NaOH is made per hour, there is also 3.55 lb. of chlorine and 0.1004 lb. of hydrogen made per hour, and that 5.85 lb. of NaCl is decomposed per hour.

Nomograph for Equivalent Diameters of Annuli

D. S. DAVIS, Chemical Engineering Dept. Wayne University, Detroit, Mich.

THE Dittus-Boelter equation [Univ. Calif. Pub. Eng., **2**, 443 (1930); McAdams, "Heat Transmission", p. 169 (1933) and "Elements of Chemical Engineering", p. 134, New York, McGraw-Hill Book Co.]:

$$h = 0.0225 \frac{k}{D} \left(\frac{D\ u\ \rho}{\mu}\right)^{0.8} \left(\frac{c\ \mu}{k}\right)^{0.4}$$

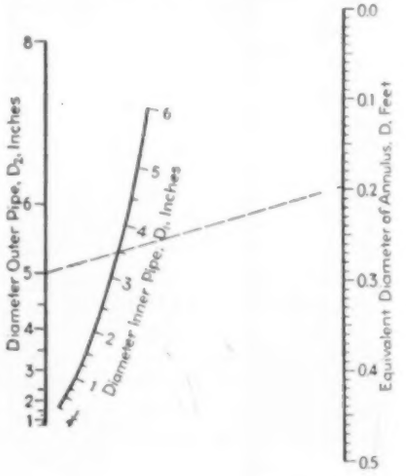
is used in estimating the film coefficient of the fluid flowing in the annular space between standard iron pipes although it was originally developed to cover turbulent flow inside clean, round pipes where D is the inner diameter of the pipe in feet. For annuli, D is replaced by the equivalent diameter as given by the expression,

$$D = \frac{D_2^2 - D_1^2}{12\ D_1}$$

where D_1 is the outer diameter of the inner pipe and D_2 is the inner diameter of the outer pipe, both in inches.

While actual diameters must be used in the latter equation the accompanying nomograph permits convenient calculation of the equivalent diameter in terms of the nominal pipe sizes. The use of the chart is illustrated as follows: What is the equivalent diameter of the annulus between 3½-in. and 5-in. standard iron pipes? Connect 5 on the D_2 scale with 3½ on the D_1 scale and read the equivalent diameter as 0.197 ft. on the D scale.

Nomograph giving equivalent diameters for annular spaces between concentric pipes



Machinery, Materials and Products

CHEM & MET PROCESS EQUIPMENT NEWS

Blackout Blinds

NEW industrial blackout blinds, manufactured of heavy crepe fiber, have been announced by Clopay, 1207 Clopay Square, Cincinnati, Ohio. These blinds, claimed to be completely lightproof, are said to be available at one-seventh the cost of opaque cloth. They are of the cord type, raising and lowering readily, when the control cords are pulled. A practical method of overlapping is employed, which makes the blinds adaptable to windows of any size or number. A flameproofing process makes them incapable of supporting combustion. The same crepe fiber material is available for outside installation on skylights and for effectively blacking out sawtooth buildings without the usual reflections resulting from most methods.

According to the manufacturer, the original installation cost of such blinds is about the same as paint which, of course, becomes ineffective when the glass is broken.

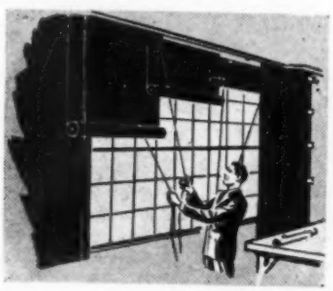
Coal-Fired Heater

TO ENABLE industrial concerns to comply with government requests for conversion from oil to coal for heating purposes, the Dravo Corp., Pittsburgh, Pa., has designed a new direct-fired coal-burning unit heater made in eight sizes from 750,000 to 4,000,000 B.t.u. output per hour.

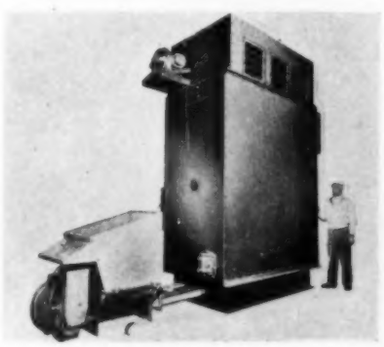
As in the case with other direct-fired heaters made by this company, the unit is entirely self-contained, having its own combustion chamber, and distributing warm air either directly from outlet vents into the area to be heated, or when partitions or obstructions make it necessary, through a simple duct system. An underfeed stoker for either bituminous or anthracite coal is available in both hopper and bin-feed types. The unit is also obtainable for hand-firing. A corrugated combustion chamber is employed, having fins and deflectors which make possible heat transfer to a moving air stream at about the same rate per square foot of surface as is obtained in a boiler, according to the manufacturers.

The new unit may be installed during plant construction and used for temporary heat, after which it is retained as a permanent system. Owing to the simple method of warm air distribution, and to the construction of the unit itself, a 40-50 percent saving in steel as compared with a boiler plant is affected, according to the manufacturer.

Fiber blackout blinds



Stoker-equipped unit heater



Plastic Window

DEVELOPED by the Plastics Division of Monsanto Chemical Co., Springfield, Mass., a new transparent plastic, laminated with wire mesh, is available for use instead of glass in the windows of military establishments and industrial plants situated in potential air raid zones. This material, developed by the company in cooperation with the U. S. Navy, is claimed to withstand the explosion of a 150-lb. bomb 8 ft. away and to withstand a 28-in vacuum without appreciable damage. Although a ¼-lb. ball dropped from a height of 20 in. smashes ordinary glass, a 2-lb. ball dropped from 42 in. is necessary to penetrate a pane of the new material.

Hydraulic pipe bender

This pane consists of standard 16-mesh wire screening sandwiched between two sheets of Vuelite, this company's transparent cellulose acetate sheeting originally produced for fluorescent lighting fixtures. The material is as clear and transparent as a screened window of glass, and can easily be installed in any conventional multi-paned steel or wood sash. Eight standard panel sizes are available. Standard panels are drawn with a ¼-in. flange which can easily be stapled to a wood sash, then puttied to form a weather-tight permanent installation.

Pipe Bender

BENDS up to 180 deg. in iron and steel pipe, as well as in solid bars of mild steel from ⅜ to 2 in., can readily be made without heating or filling by means of a new portable hydraulic pipe bender introduced by Tal's Prestal Bender, Inc., Milwaukee, Wis. The machine comes equipped with seven different sizes of formers, the total weighing 158 lb. The machine alone, with the 2 in. former shown in operation in the accompanying view, weighs but 98 lb. The machine consists of a pipe holder frame, hydraulic jack, and a former attached to the plunger of the jack. Three minutes or less is required to produce bends in any size of pipe up to the capacity of the machine, according to the manufacturer.

High Pressure Meter

ULTRA HIGH-PRESSURE flow measurement is possible, according to the Cochrane Corp., 17th St. and Allegheny Ave., with a new high-pressure flowmeter manometer of the ring balance type which has recently been introduced. A manometer of this type requires no stuffing box, float or pressure-tight bearing. A stainless steel ring, 15 in. in diameter, balanced on a knife edge, contains mercury as the manometer fluid. The ring is partitioned at the top, connections being made to the two sides by nickel torsion tubes, located at the center of rotation. The ring tilts 10 deg. for the

full differential which may be between 4 and 9 in. of mercury, depending on the cam weight supplied. As in other ring balance meters of this company's design, a cam and weight arrangement is provided to extract the square root relationship so as to express the flow directly in uniform increments on a 36-in. indicating scale and/or 12-in. circular chart.

Such meters are tested under 7,500 lb. per sq.in. pressure and are being employed in several synthetic ammonia plants at pressures above 5,000 lb. per sq.in.

Industrial Wood Fence

To COMPLY with steel restrictions in fencing, the Rock Island Sash & Door Works, Rock Island, Ill., is manufacturing a new industrial wooden fence, which weighs 20.4 lb. per lin.ft., permitting the shipment of 2,000 lin.ft. per car. According to the manufacturer, this fence has the approval of the Army Engineering Corps and has been given a thorough tryout.

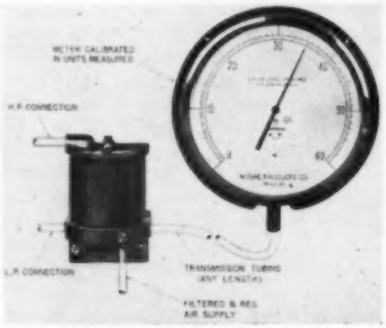
Pneumatic Transmitter

A NEWLY DEVELOPED pneumatic device for the transmission of differential pressures to a remote indicating or recording instrument is being offered by Moore Products Co., H and Lycoming Sts., Philadelphia, Pa. This device measures and amplifies small differential pressures, producing an output pressure proportional to the differential which can be transmitted over a considerable distance to a receiving meter calibrated in the units measured. The new transmitter is said to give true linearity of response and a constant ratio of amplification, the latter being varied to suit the specific requirements and depending only on the fixed ratio of areas of a high-pressure and low-pressure bellows. No levers or sliding elements are used. A separate pilot is provided where a long transmission distance is required.

The instrument consists of a chamber in which is a bronze or stainless steel bellows, the low pressure tap connecting to the space outside the bellows, with the high pressure tap connecting inside. Air from a filtered and regulated supply enters the inside of a small diameter bellows concentric with the larger one. This air bleeds from an exhaust nozzle at a rate controlled by the balance point achieved by the large bellows under the existing differential pressure. The regulated pressure within the small bellows is then transmitted by tubing to the indicating instrument.

This method is described by the manufacturer as the pneumatic equivalent of the electric null system in that it is independent of bellows characteristics. The system can readily be checked for zero point and can be supplied with liquid seals if necessary.

Industrial wooden fence



Differential pressure transmitter

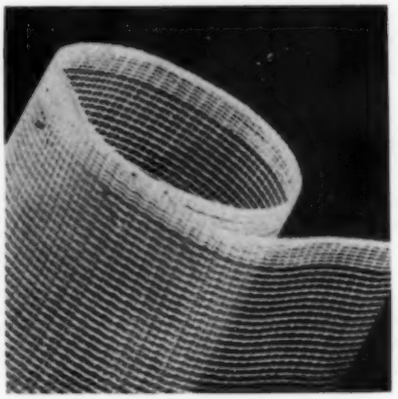
It is suitable for transmission of indications in connection with liquid level, interface level, flow in pipes, ratio flow control, specific gravity, temperature compensation of specific gravity, or temperature measurement.

Plastic-Mesh Fabric

TEN-MESH FABRIC, the openings of which are filled with a transparent plastic, is available under the name of Ceco safety cloth from Colloid Equipment Co., 50 Church St., New York, N. Y. This material, which is nonshattering in the event of bombing, may be used instead of window glass, or may be applied inside, over the regular window glass, to minimize the shattering effect of a nearby explosion. The safety cloth is said to transmit 89 percent of the light of 4,000 angstrom units range and 76 percent of the ultraviolet light of 3,600 angstrom units range. It is weatherproof, flexible and easy to handle. It can be cut with scissors and tacked up on a wooden sash, using unskilled labor. For use over steel sash, the material may be set up in special frames or secured by metal strips screwed into holes drilled in the sash. The cloth comes in rolls of 300 ft., 28 in. wide.

Inclosed Motor

COWL-COOLED is the name of the latest fan-cooled motor developed by Crocker-Wheeler Electric Mfg. Co., Ampere, N. J. The motor is totally inclosed, and especially adapted for use in dusty locations. As appears from the accompanying illustration, the frame carries a number of heavy



Ceco safety cloth

External-cooled inclosed motor

ribs parallel to the shaft. At the right hand side, a cowl ring covering the fan wheel will be observed. Air is drawn into the fan at the center of the cowl ring and then blown over the external ribs. There are no internal passages for cooling air, and thus the motor is claimed to be particularly suitable for service in destructive fumes, abrasive dusts, oil or dirt.

This motor is built with either sleeve or ball bearings, in the same frame sizes used for open motors of corresponding horsepower ratings and speeds, and in sizes up to 20 hp.

Blackout Light Control

SWITCHING EQUIPMENT intended to provide low intensity light during blackouts has recently been made available by Automatic Switch Co., 41 East 11th St., New York, N. Y. In many applications it is desirable to provide low intensity light for essential movement with safety, whenever the main lighting is turned off during a blackout. The new equipment consists of a switching arrangement having two sets of contacts so arranged that, being operated by the same mechanism, when the contacts for normal lighting are closed, the special blackout lights are disconnected, whereas when the normal lighting contacts are disconnected, the blackout lights go into operation. The unit can be controlled either manually, or remotely from one or more push-button stations. Customarily a second source of power should be provided for

the blackout light, for control and communications. Automatic transfer switches should be provided to insure continuity of operation from either available source.

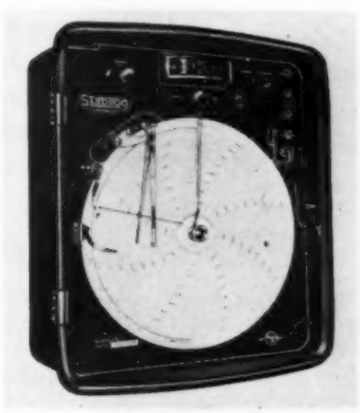
Standard Bearing Covers

WITH THE APPROVAL of all leading manufacturers of ball and roller bearings, R-S Products Corp., 4530 Germantown Ave., Philadelphia, Pa., has commenced the marketing of a line of standard covers designed to form a dust- and grease-tight closure to the bearing housing. These covers, available in a complete range of types and sizes, are low in cost and are said to simplify materially the problems of the designer and draftsman and to eliminate the costs of patterns, fixtures, gages, etc.

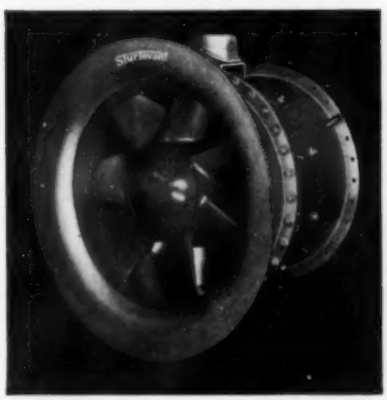
Fast-Stabilizing Control

HYPER-RESET is the name of a new control function which is now available in the newly designed Model 30 Stabilog controller, manufactured by The Foxboro Co., Foxboro, Mass. In tests of instruments in which this function was incorporated, it is claimed that process stabilization following an upset was reestablished in one-quarter of the time, and with only one-half of the upset effect, as compared with a similar controller having only the usual reset. Hyper-Reset is said to reduce the effect of a process disturbance by making initial temporary additional corrections which are proportional to the rate of change of the measured variable caused by the disturbance. The normal reset follows, establishing stabilization. However, the several control functions carried out by the device are simultaneously and automatically adjusted. No tuning-in is necessary, and no more than two process adjustments are required, proportional and Hyper-Reset.

Model 30 Stabilog with Hyper-Reset



Victory Axiflo fan

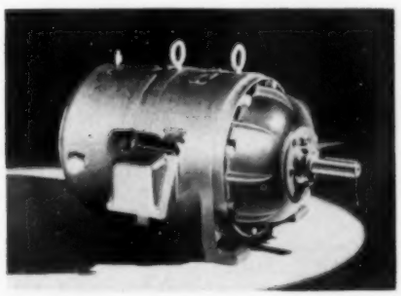


Check Valve

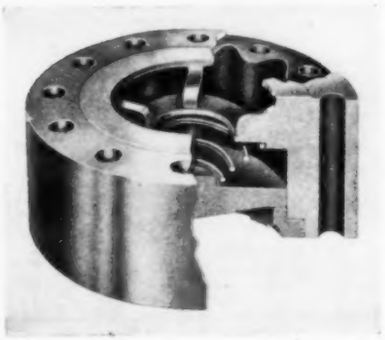
IMPROVEMENTS in a new line of check valves have been announced by the Williams Gauge Co., 2018 Pennsylvania Ave., Pittsburgh, Pa. These valves are available in a wide variety of metals and sizes. Designated as the Williams-Hager Flanged Silent Check Valve, their rated pressures range from 150 to 2,500 lb., their sizes from 1 to 20 in. Simple, compact and rugged design has been employed. Only two parts are subject to wear, the valve disk and the seat, both of which are easily removable and renewable, reseating being possible without special tools. As appears from the accompanying illustration, the spring ring is built as an integral part of the body.

According to the manufacturer, these valves are particularly suited for use in water service, oil refining, chemical manufacture and other non-return flow lines. In general, they can be used in all pump lines handling water, oil, gas, certain acids, alkalis, and other liquids.

Motor for magnesium-dust locations



Flat-disk check valve



Axial Flow Fan

A RECENT ANNOUNCEMENT of the B. F. Sturtevant Co., Hyde Park, Boston, Mass., describes the company's new Victory Axiflo fan which is claimed to offer features in performance, quietness of operation, saving of weight, space and power, which have never before been approached in fans of the axial flow type. The fan is not yet available for industrial use, since the entire production at present is required by the U. S. Navy for use in heating, ventilating and mechanical draft service.

The new fan is claimed to have an exceptionally high mechanical efficiency of 90 percent, and to be extremely quiet in operation, as well as light in weight and small in size. It weighs only about 60 percent as much as other fans for comparable service. Pressures range from ½ to 6 in. w.g. in the motor-driven type, with turbine-drive models available for pressures as high as 60 in. w.g. After the emergency, a wide range of sizes will be available for industrial use.

Several novel features characterize the design of the new fan. A special motor is supported in the center of the duct section by a number of "Streamvanes" which are welded to the motor and the inside of the fan housing, serving not only to cool the motor, but also to straighten the air flow from the rotor, reducing turbulence and resistance in connected ducts. The rotor itself is of a novel stream-lined design, the blades being shaped in such a fashion that the same amount of work is performed at every radius, thus giving great flexibility of volume without change in pressure.

Magnesium-Dust Motor

SUITABLE for use under magnesium-dust conditions, a new motor labelled as acceptable for Class II, Group E hazardous locations has been announced by General Electric Co., Schenectady, N. Y. These new polyphase induction motors are made in sizes from 1 to 20 hp. and are intended particularly for use in plants handling fine magnesium powders, as in the manufacture of incendiary bombs. The motors are totally inclosed, with a non-ventilated construction in the smaller ratings, and a fan-cooled construction above 2 hp. Dust-tightness is said to be achieved without complications. The motors feature non-sparking bronze external fans; relatively straight and smooth external ventilating passages in the fan-cooled motors; permanently sealed-in leads; and a rotating labyrinth seal at the shaft opening.

Equipment Briefs

A BUILT-IN chain reducer, with the output shaft in exact alignment with the input shaft, is now being offered in combination with a variable speed

transmission, in a special design manufactured by the Reeves Pulley Co., Columbus, Ind. Output speeds may either be increased or decreased, as compared to the variable speed shaft of the transmission. They are, of course, infinitely variable within predetermined limits by turning the speed control hand wheel. The chain drive operates in a bath of oil.

FOR USE where electric operation seems best fitted to the job, Clark Tructractor Division of Clark Equipment Co., Battle Creek, Mich., is now prepared to supply electric-powered fork trucks, platform trucks and tractors. Formerly this company manufactured only gas-powered trucks. The new machines lift from 2,000 to 7,000 lb. using a hydraulic vane-type pump driven by a special series-wound motor. The same pump operates the tilting unit which enables the operator to tilt the load back 10 deg. in 5 second for safe riding, or tilt it forward 3 deg. in 1 second for tiering. Four speeds in either direction up to 6 m.p.h. under full load are standard.

A USEFUL ACCESSORY for heavy welding is a new holding magnet or magnetic welding clamp now available from Stearns Magnetic Mfg. Co., Milwaukee, Wis. The magnet is available in various sizes. For example, one of 10 in. diameter, weighing about 70 lb., exerts a pull of 2,000 lb. on $\frac{3}{4}$ and 1 in. steel plates. Through use of such a clamp it is said to be possible to draw the plates to level alignment with the edges brought flush against the perfect surface of the magnet. By tacking welds to the plates on either side of the magnet, the welder is able to maintain alignment readily and achieve quick results.

TWO NEW PIECES of air raid equipment are available from Specialties Mfg. Co., 35 Farrand St., Bloomfield, N. J. One is a 20-gal. barrel pump extinguisher mounted on wooden wheels, with carrying handles to permit its being carried upstairs by two people. The barrel is provided with a tight cover to prevent evaporation and a stirrup pump with a 12-ft. length of hose. An ax is included in the assembly. The other unit is a portable sand barrel for the extinguishment of incendiary bombs. Like the pump barrel, this consists of an open top barrel of approximately $2\frac{1}{2}$ cu.ft. capacity, mounted on wheels and equipped with handles for carrying upstairs. A long-handled shovel and an ax are part of the assembly.

Packing Material

RESILIENT packing material made of kraft paper stock, expanded into a honeycomb pattern so as to resemble expanded metal, has been introduced as a shipping packing material by Research Products Corp., Madison, Wis. The material is light, uniform and easy to handle. The expansion process gives it a third dimension, and hence resilience. As shown in the accompanying view, it can be wrapped around double-curved objects, such as the chimney and bulb shown.

Motor-Operated Valve

FOR PROCESS WORK where close regulation is required in the handling of steam, water, oil or gas, Barber-Colman Co., Rockford, Ill., has introduced the new Microvalve, a motor-operated valve with a proportioning type operator. The valve operator consists of one of this company's Microtrols, with the addition of an eccentric cam which operates the valve plunger. Valves are built in single-seat V-ported, double-seat V-ported, and double-seat, three-way designs.

Impact Crusher

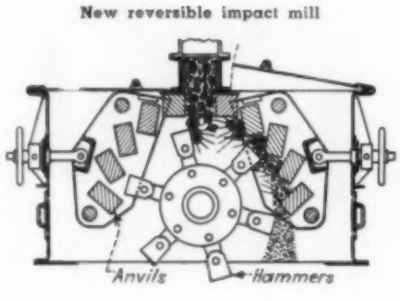
A NEW CRUSHER designed to operate almost entirely by impact, with a minimum of attrition and abrasion, has been introduced under the name of Reversible Impactor by the Pennsylvania Crusher Co., Liberty Trust Bldg., Philadelphia, Pa. According to the manufacturer, such a mill causes a particle rupture much like that produced by an internal explosion, normally giving a different particle shape than is obtained by plain, slow compression breaking. It is claimed to minimize over-grinding and to permit high reduction ratios.

The new mill consists of a rotor carrying swing hammers, on either side of which are arranged a group of heavy anvils against which the feed is batted by the hammers. The mill has no cage and thus material cannot be held in the mill and subjected to attrition. The larger pieces rebound into the beater circle and are repeatedly thrown against the anvils. Fines are removed from the mill by an air stream, and for best results the mill should be operated in closed circuit.

The novel feature of this design is the use of two groups of anvils, one arranged on either side of the machine. Feed enters at the center over the rotor and the direction of rotation determines which group of anvils is active. A reversing switch is provided so that the direction of rotation can be selected and either set of anvils used, in effect, giving two mills in one. Handwheels are provided at either side for quick adjustment of the anvils.

Kraft paper packing material

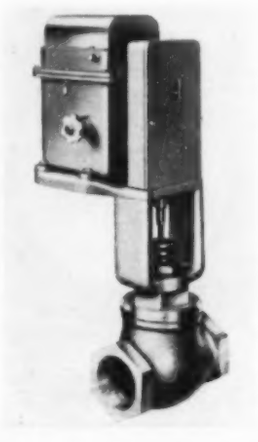
New reversible impact mill



Automatic Scale

SEVERAL interesting features are obtainable in a new automatic weighing scale designed for rapid and accurate handling of coal and other free-flowing bulk materials, and manufactured by Beaumont Birch Co., Philadelphia, Pa. Material is conveyed from the feed hopper to a weighing hopper by means of a vibrating metal feeder deck which eliminates all rubber belts, pulleys and other rotating mechanisms. The scale is totally inclosed in a dust-tight, welded steel case, and is built in three standard sizes for handling quantities ranging from 1 to 30 tons per hour. On special order, larger sizes having weighing capacities up to 60 tons per hour can be furnished.

Electric-operated control valve



Automatic weighing scale

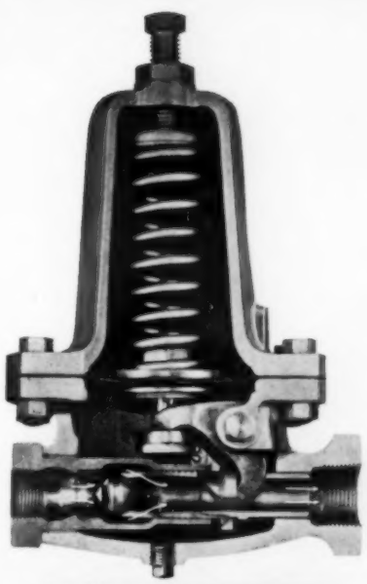
One SHIFT A DAY or Three

CASH STANDARD Streamlined TYPE 1000 PRESSURE REDUCING VALVES

Go the Full Route YEAR AFTER YEAR . . .

Here's what happens with the Streamlined "1000" Valve on the Job

1 Maximum Capacity when needed most
2 Accurate Pressure Control under toughest working conditions
3 Trouble-free Service
4 Smooth Operation
5 Tight Closure
6 Accurate Regulation
7 Speedier Production Results
8 Elimination of failures
9 Constant Delivery Pressure
10 Cost Saving Operation
11 No Spoilage
12 Practically zero in maintenance costs

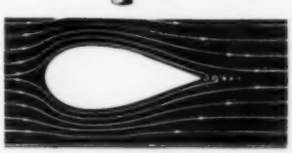


"24 hours a day"

"The particular Streamlined Pressure Regulator you refer to is installed on a paper machine making tissue paper. Pressure fluctuations are not desirable. In fact, to maintain a good, uniform quality of paper, and to get the utmost out of the machine in the way of production, sensitive pressure control is of prime importance. And because the machine runs 24 hours a day, dependability is equally important. Your valve has never missed a trick. Our operating department is well pleased." —Case No. 340.

"No trouble over a five year period"

"Bought the first '1000' Valve because we were on a hunt for a dependable Valve. Laboratory tests were so good we standardized on it. Plant use confirmed lab tests. With practically no trouble with any of these Valves over a five year period, we are not on the hunt any more."—Case No. 369.



GIVES THIS FLOW PATTERN
The Streamlined form of the inner valve eliminates turbulence. It produces the flow pattern shown above which makes for maximum capacity when it is needed most, and permits accurate pressure control under toughest working conditions.

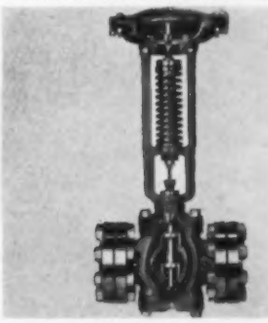
Send for Bulletin "1000"

● *Gives you full details on all of the twelve points listed above. Steam, air, and water capacity charts are shown.*

A CASH STANDARD "GET ACQUAINTED" COLUMN

Question: "Don't you people make anything besides that Streamlined Valve you talk about so much?"

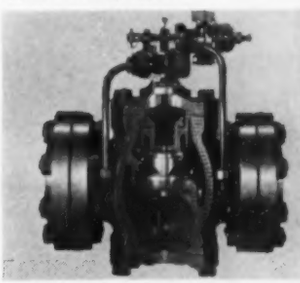
Answer: "Yes Sir; we do! And we propose to picture one or two of them here each time."



Cash Standard Type 34 Pressure Reducing Valve. For practically all fluids. Sizes: ½" to 12" inclusive. Highest initial pressure 800 lbs.; reduced pressure, vacuum to 150 lbs.

The best that money can buy in this type valve. Precision built; every mechanical detail right as can be. Long time service. Has roller guides, roller bearing — no lost motion; a change in the pressure under control produces corrective valve movement.

Bodies: iron, bronze, steel. Trims: iron, bronze, stainless steel, monel metal. Ends: screwed, flanged, ammonia type, welding type.



Cash Standard Type 10 Pressure Reducing and Regulating Valve — self-contained, pilot operated. For holding reduced pressure within extremely close limits.

Sizes: 2" to 12" inclusive. Highest initial pressure 600 lbs.; highest reduced pressure 250 lbs. For use with water, air, Freon, ammonia; or with any non-corrosive gas or oil. Valve operating fluid not wasted; it discharges to outlet pipe.

Bodies: iron, bronze, steel. Trims: iron, bronze, stainless steel, or monel metal. Ends: screwed, flanged, ammonia type.

A dial on the pilot valve makes it easy to widen or narrow the control pressure range until you establish the ideal range for your service.

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CASH STANDARD CONTROLS . . VALVES

Formaldehyde from Natural Gas

THE GROWING IMPORTANCE of the petroleum industry in the chemicals field is again illustrated in the large-scale production of formaldehyde, methanol, and related chemicals by the direct oxidation of natural gas hydrocarbons at the Tallant, Okla., chemical plant of the Cities Service Oil Co.

Conversion of methane and other natural gas hydrocarbons directly to formaldehyde by air oxidation has received much attention in the past, but the first successful commercial plant utilizing this method was built at Tallant early in 1928. Since that time, the production capacity of this plant has been consistently expanded. Output at present is very substantial. Cities Service today is the largest producer of formaldehyde by this process—a process developed by its own research organization.

A substantially equal tonnage of methanol is produced simultaneously with the production of formaldehyde. A smaller tonnage of acetaldehyde, methyl acetone solvents, etc., are also produced. These products are produced in admixture—as a crude chemical—by the controlled partial oxidation of natural gas hydrocarbons. The crude chemical product must then be separated by fractionation into its major constituents—formaldehyde solution, methanol, acetaldehyde, and methyl acetone solvents. These fractions are further refined to commercial specifications. Methanol produced in this process has been converted largely to an anti-freeze, but substantial quantities have now been made available to other uses.

This process for the manufacture of chemicals operates at moderate temperatures and pressures and therefore does not require the expensive forgings and other scarce materials essential to synthetic processes operating at pressures of several hundred atmospheres.

The essential steps in the process of making these chemicals from natural gas are shown in the accompanying diagrammatic flowsheet. Most of these steps in the process are illustrated by photographs.

CHEMICAL & METALLURGICAL ENGINEERING

September, 1942

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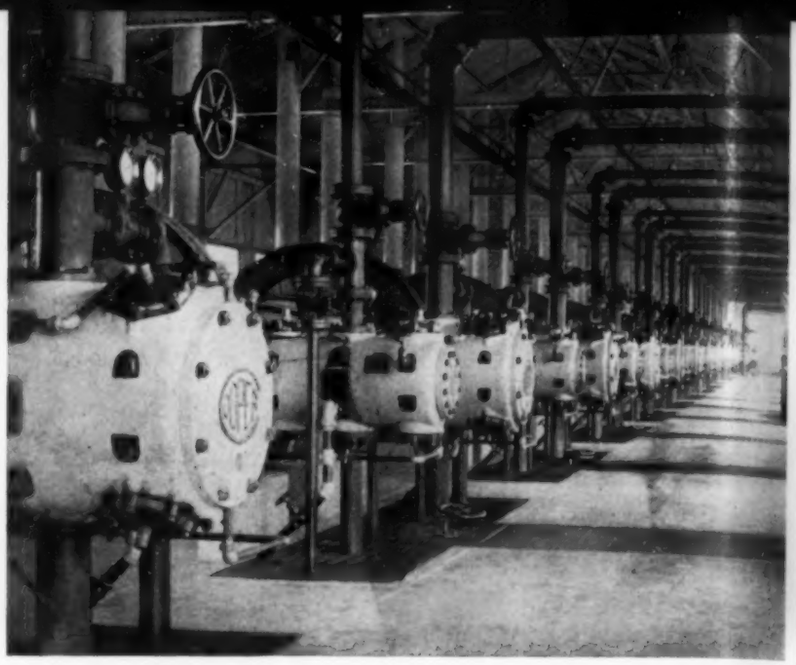
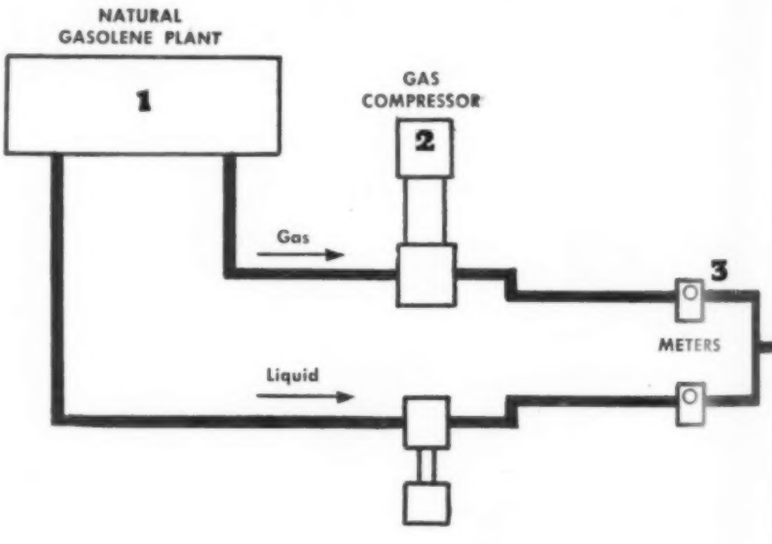
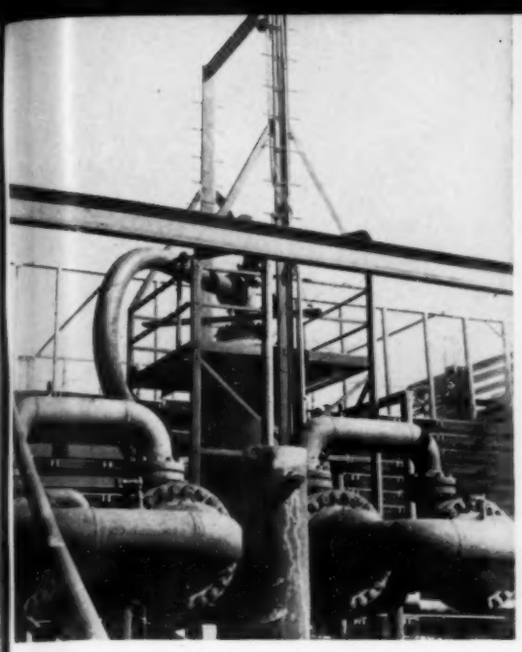


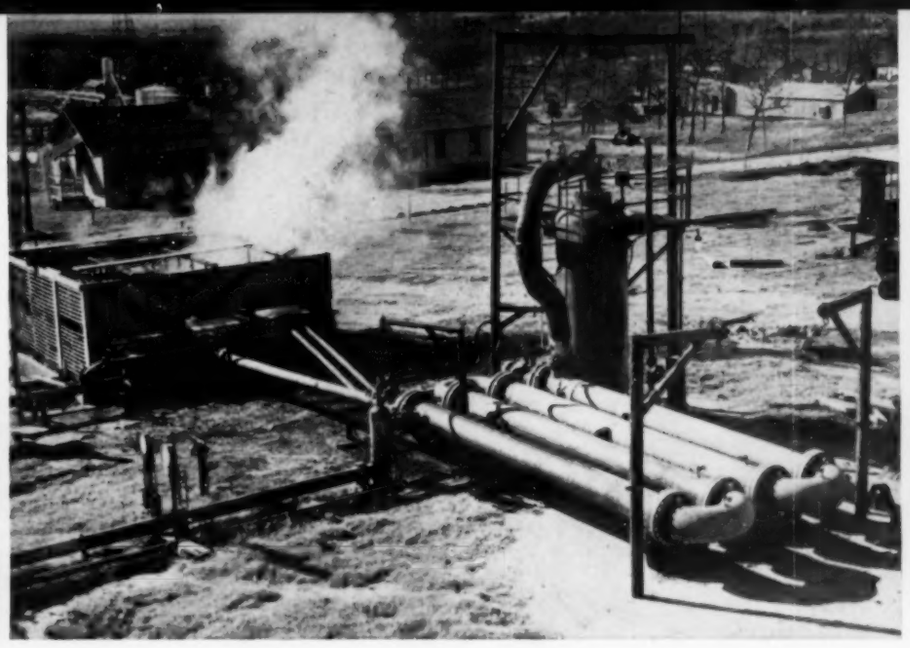
2 Compressor ends of air and gas compressors, internal combustion gas engines



1 Plant for conversion of hydrocarbon gases by high-pressure partial oxidation

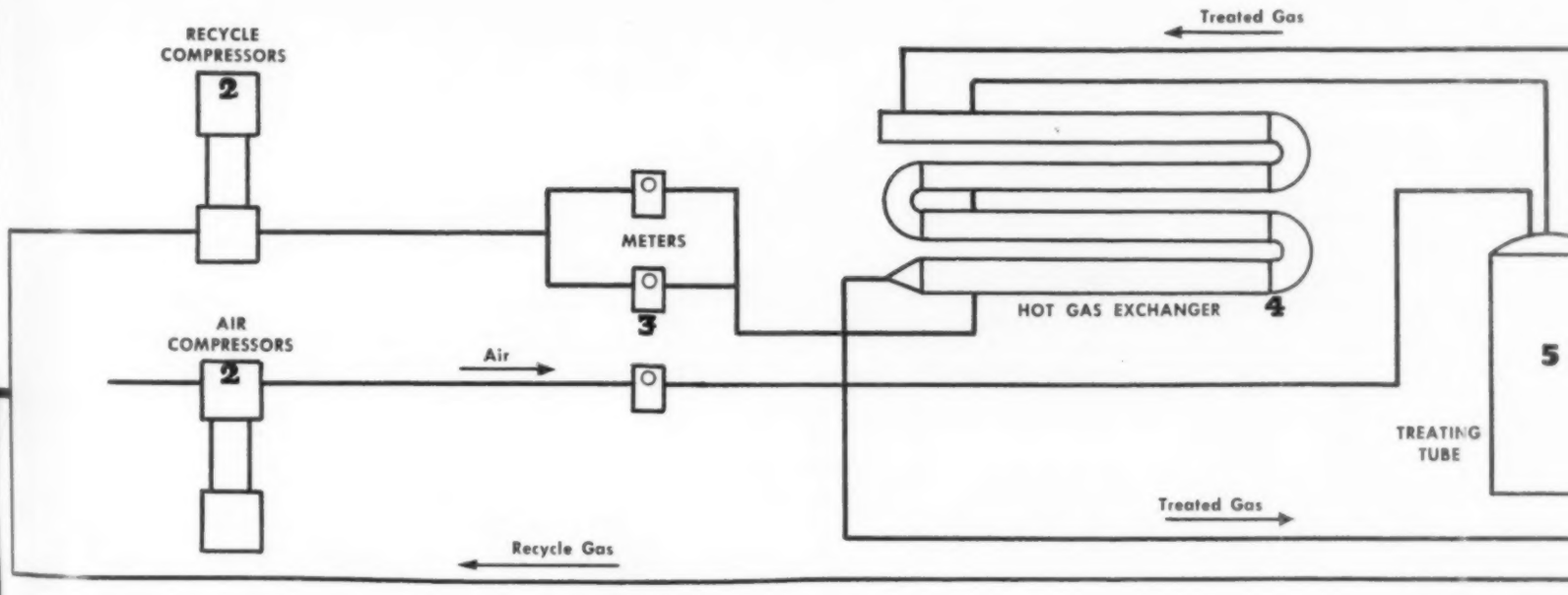


4 Heat exchangers for converter gases



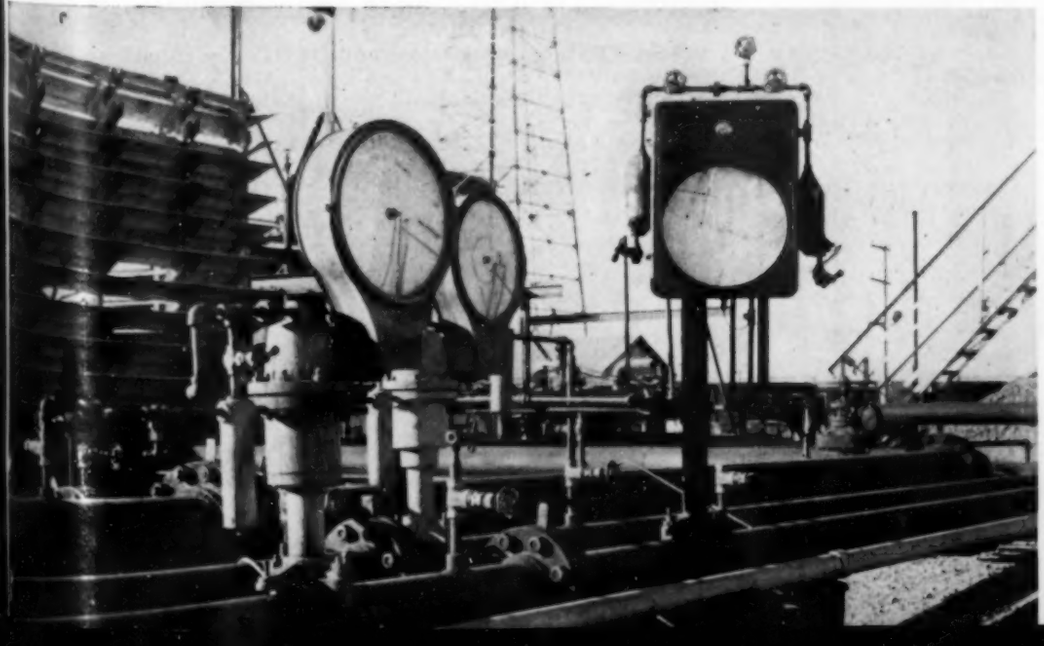
6 Heat exchangers appear in foreground, converter is in center and aftercooler on left

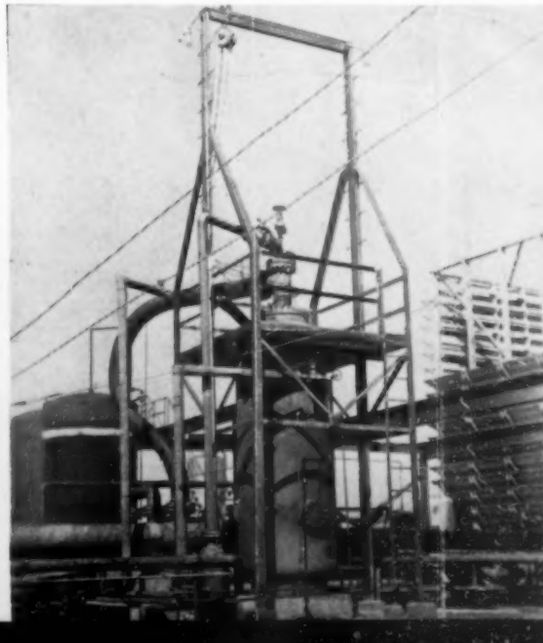
8-9 Spent gase

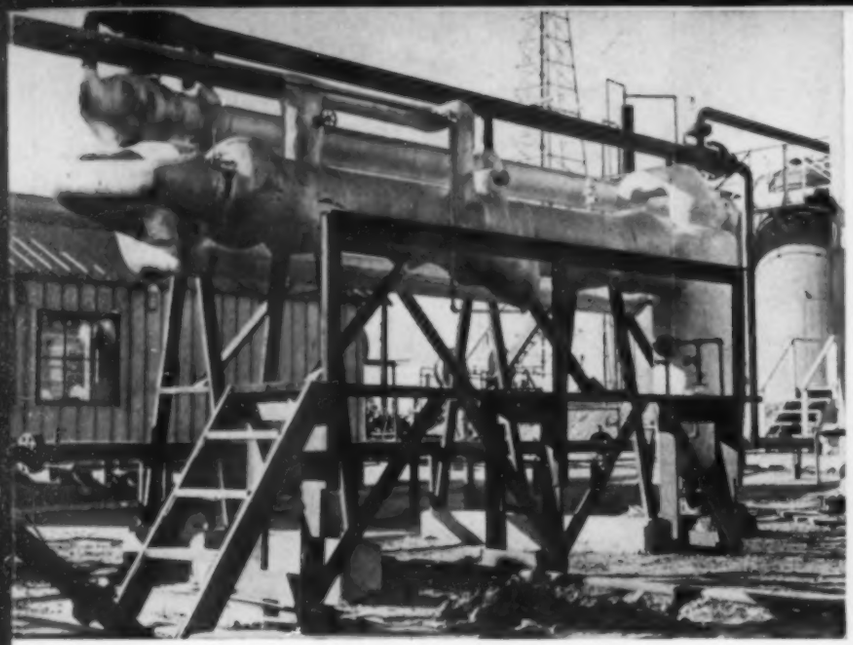


3 Meters are important in processing gases and liquids. Here they are measuring air and natural gas

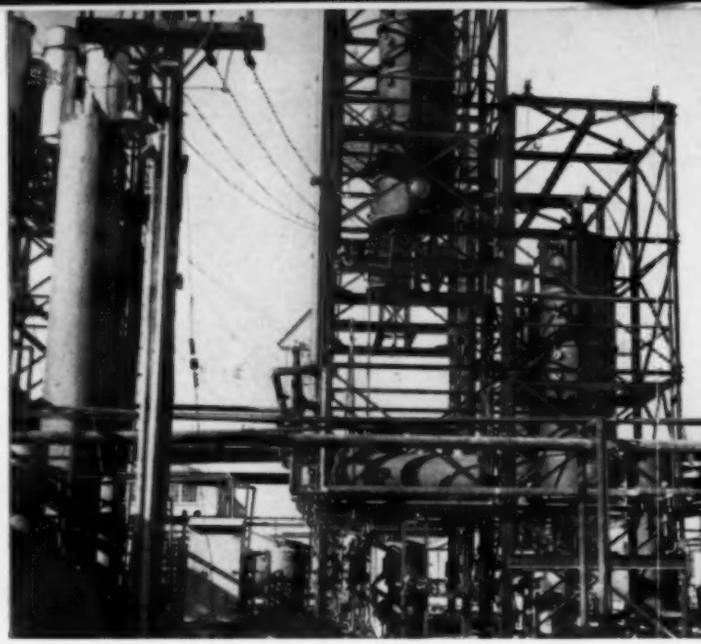
5 Air and gas are heated in the converter



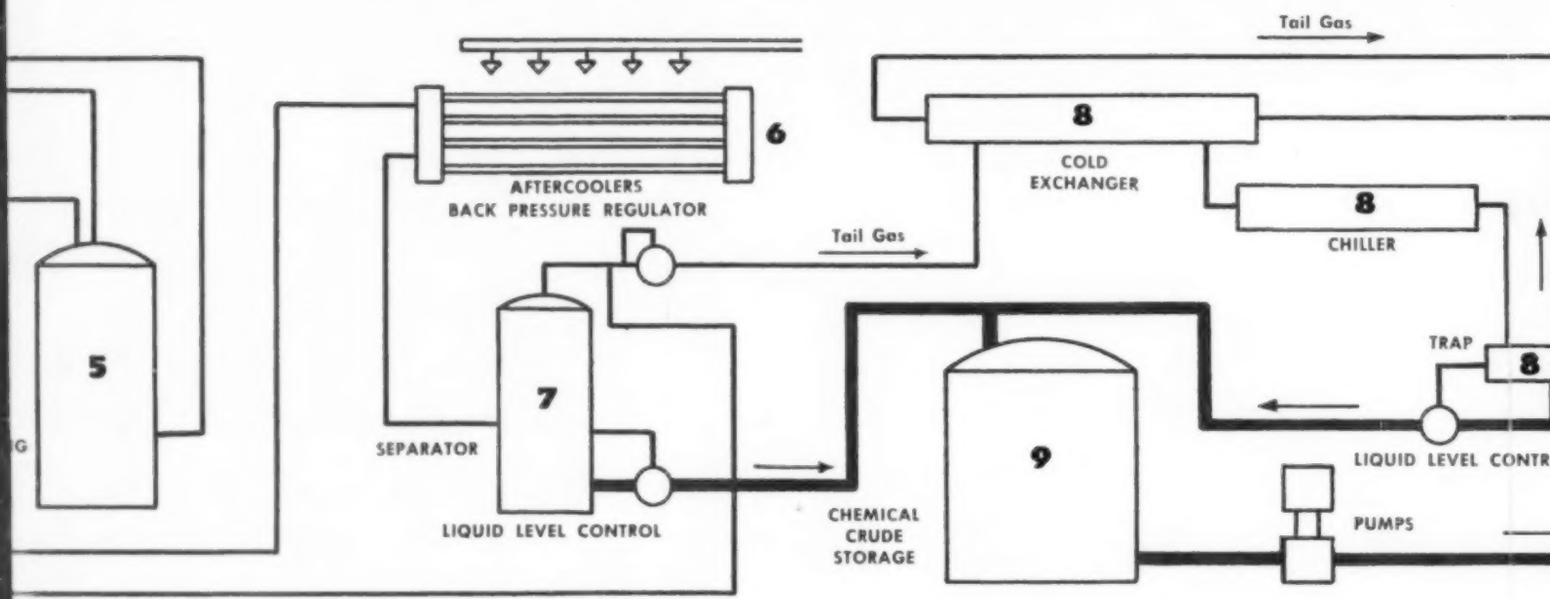




Spent gases are cooled in exchanger in center and chiller on right before removal

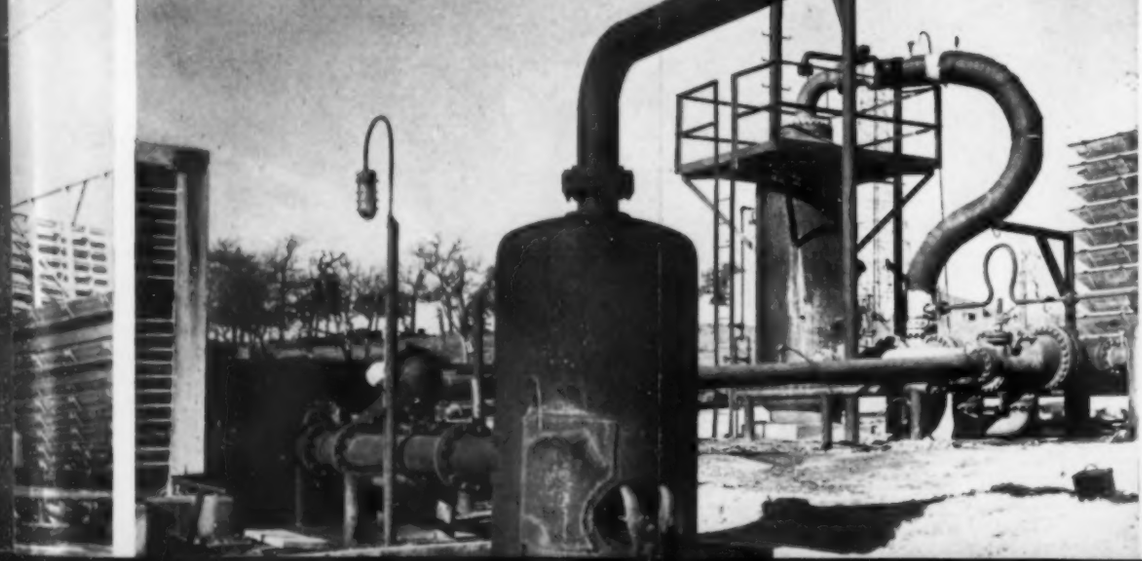


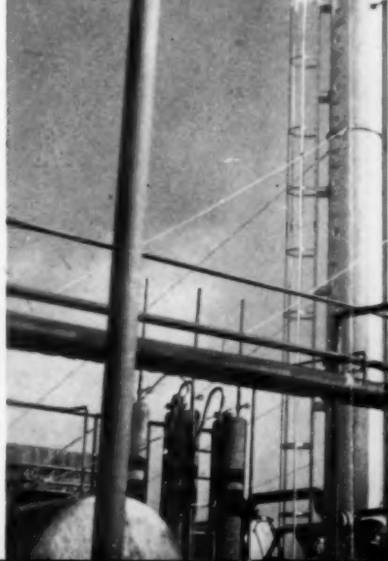
10 Continuous columns for removing methanol and other products from f



7 In the foreground is separator in which condensable products are removed. Converter in background

11 Methanol and solvent fractionatin

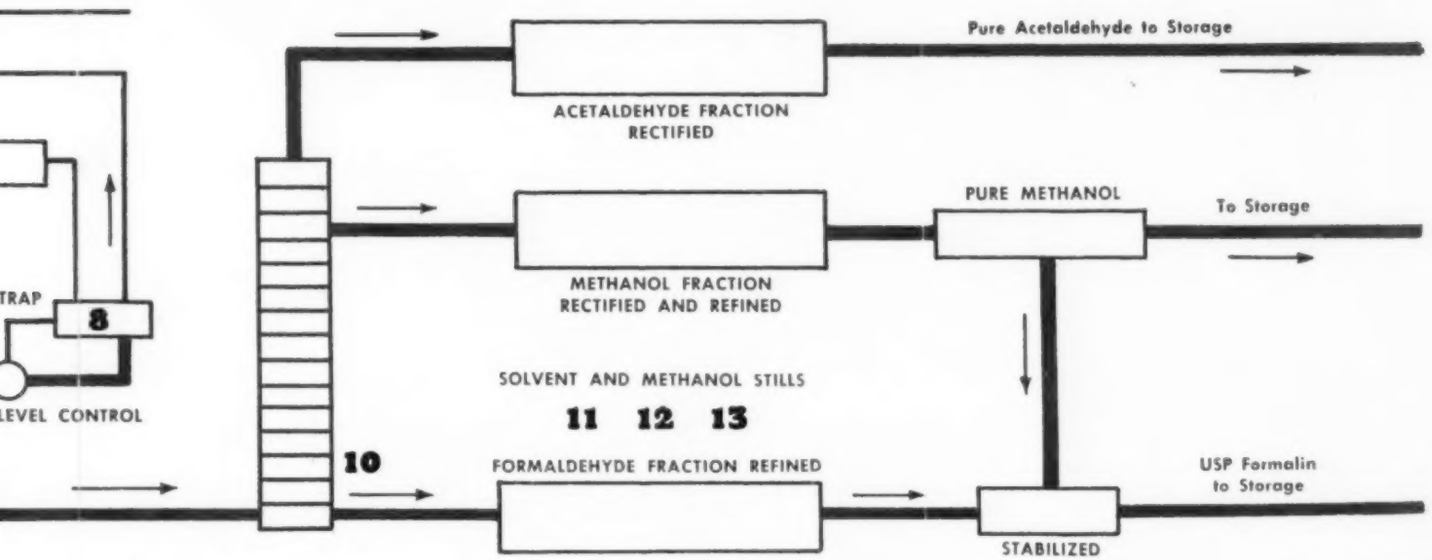




A *Chem & Met* FLOW SHEET

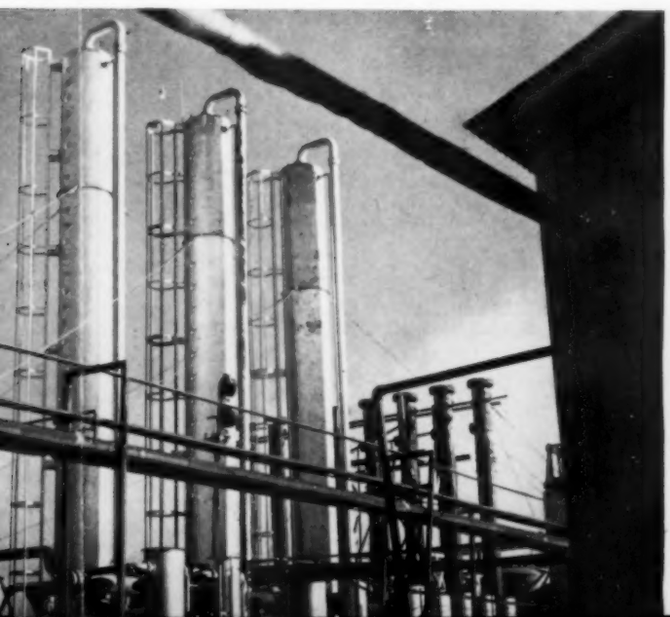
oducts from formaldehyde

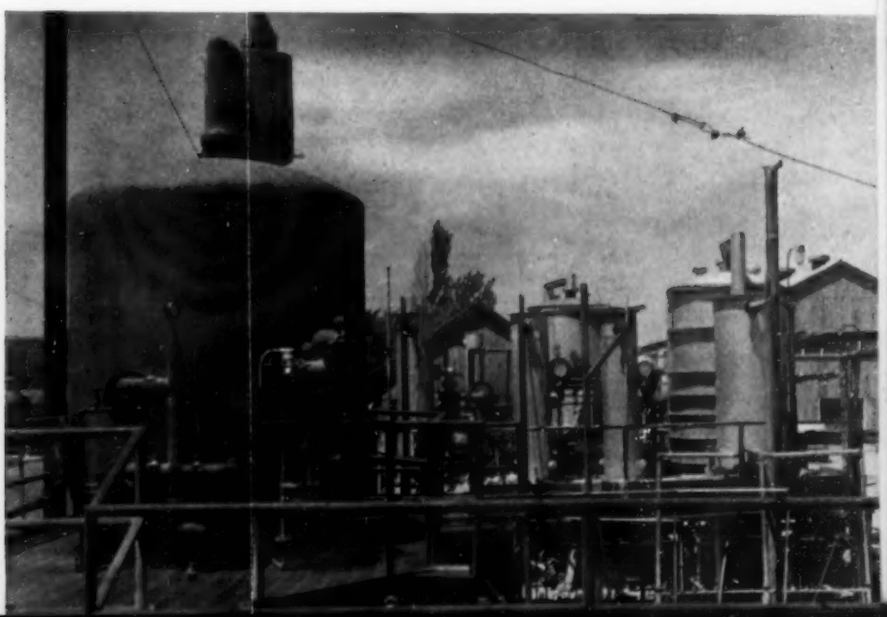
12 Methanol, acetaldehyde, and solvent fractionating and rectifying columns



fractionating and rectifying columns are shown in the center

13 Formaldehyde processing units in plant of Cities Service Oil Co. in the Southwest

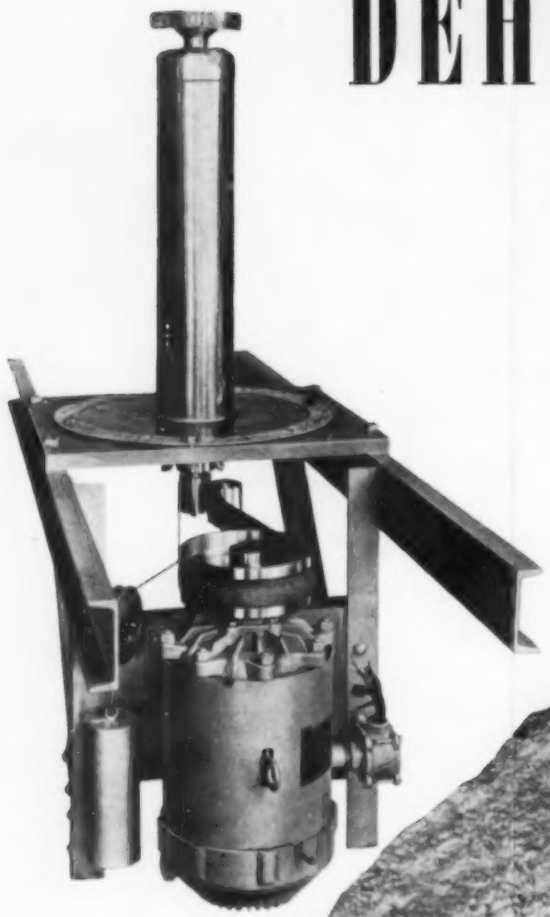




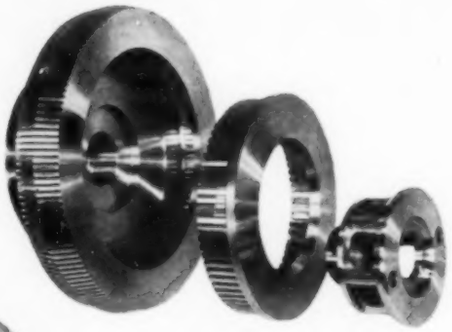
DEHYDRATION

BY "TURBULAIRE"

a story of Engineering Service



Complete assembly for a bottom belt driven atomizer.



Typical forms of atomizer heads used with the Turbulaire Spray Dryers.

• Some months ago we received an inquiry about the practical application of spray drying to the dehydration of an inorganic salt, one element of which is vital to the war program. Our pilot plant records showed tests had been made for our own research staff. Data on gas temperatures, feed consistency, moisture in final product, its bulk density and average particle size, etc., were all available. But these new specifications were more stringent; control of temperatures, final moisture and several other process details had to be more precise.

• New pilot plant tests were made. Then small scale production operations followed. Operating technique was improved, control made more accurate. Each phase of the operation was studied from every angle.

• As a result, today our field engineers are supervising erection of a large and complete spray dryer installation: furnaces, ducts with special insulation, desiccators complete with stairways and operating platforms, fans, motors, panel boards for electrical equipment and automatic temperature control instruments, Multiclones and special scrubbers.

• Soon our operating engineers will put this plant in operation and show the plant staff how it should be run. Our client is as confident as we are that this job will have as few "bugs" to iron out as is possible in an operation of this magnitude and complexity because it has been carefully engineered, tested and checked from every angle possible, short of full-scale production. It is a turn-key job and back of it all is 35 years of experience.

. . . SEND FOR THIS BULLETIN

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NON-CRITICAL MATERIALS HELP COMBAT CORROSION!

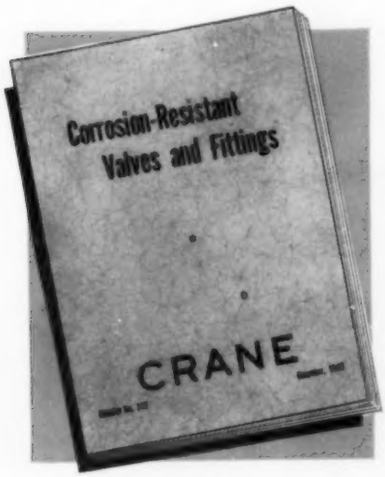
Two Crane Technical Publications Take on a New and Timely Significance

". . . These publications are replete with comparisons between ferrous, nickel, copper, nickel-copper, and nickel-chromium alloys in contact with a large number of different environments. In many cases, these comparisons show that a non-strategic material can be used, even though better results would be obtained from one of the alloying materials which is now needed more vitally for other purposes. The accompanying discussions sometimes show that the need for special alloy material results from some design feature, and that a change in some of the piping can sometimes eliminate the need for a high order of corrosion resistance . . ."

★

With the use of nickel, chromium, copper and other alloying elements for piping equipment drastically curtailed, many engineers are faced with new problems in combating corrosion.

Men having such problems will find much valuable information in these Crane publications on "Combating Corrosion in Industrial Process Piping" and "Corrosion-Resistant Valves and Fittings." Both publications have been in the technical libraries of many plants since they were first issued in 1939.



It will be worth your while to refer to them again at this time—or to send for copies if you do not already have them. For they contain much specific information on where currently available materials can be used with reasonable satisfaction. "Corrosion-Resistant Valves and Fittings," for instance, contains a chart listing nearly 200 different corrosive chemicals and indicating where iron and steel may be used. "Combating Corrosion" presents an exhaustive list of suggestions for handling corrosive fluids, many of which show how non-critical materials may be used.

All data prescribed are predicated both on Crane's laboratory research and upon the wealth of field experience made possible by the breadth of Crane's contacts as the nation's leading manufacturer of valves and fittings.

COPIES AVAILABLE WITHOUT CHARGE

As a service to American industry, at war, Crane is glad to make these publications available to engineers without charge. Write today for your copies.

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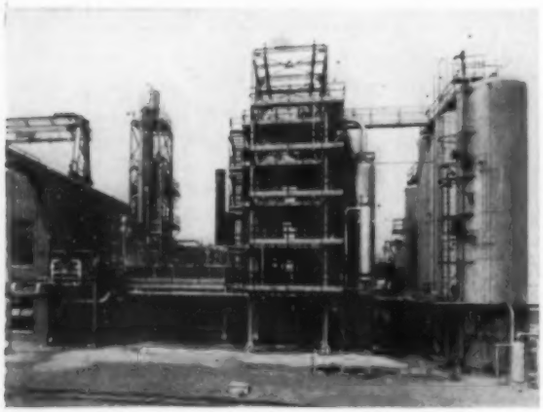
A STRONG CHEMICAL INDUSTRY

Accepts the Challenge



This war we are fighting presents a challenge to our chemical industry!

Production of existing chemicals has had to be stepped up to unforeseen tonnages. New chemicals, particularly in the synthetic group, have had to be worked out in the laboratory and then translated into full-scale production . . . *quickly*.

War has flung down the gauntlet, and industry has accepted the challenge.

Much of the underlying strength of the nation's chemical industry can be traced to the soundness of engineering designs and skill in construction contributed by independent, unbiased engineering and construction services.

Badger Engineers and Constructors are proud to be among those serving the chemical industry at this time . . . serving it by designing and building efficient plants and units in—under existing handicaps—record time.

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CHEMICAL ENGINEERS WILL BE SCARCE FOR INDUSTRY

Chemical engineers for process industry are going to be scarce. The War Manpower Commission knows this and is trying to protect essential war-time industry against too great a depletion in technical personnel. Several plans have been formulated and are being put into action as rapidly as possible.

Training of young scientists and engineers in technical institutions of full college grade continues with the encouragement of the Manpower Commission on a speed-up program in most schools. But students are warned that merely going to college and taking an approved course with acceptable standing is not enough. They must be working directly toward a war job to expect any deferment. And privately the leaders of this program know that at least two-thirds of the graduates will undoubtedly find themselves in uniform promptly after graduation. The need for technically-trained officers is so great that this seems unavoidable.

Research personnel will be protected as far as possible, as well as operating plant men. But local draft boards do not recognize the importance of scientists and engineers in the research laboratory as keenly as they might. Special effort must be made by managements to protect these men under these circumstances, officials explain. But here again the research laboratories cannot be a haven for those who do not have combatant disposition.

Technical men are being urged, where their present work is not importantly traceable to war-time need, to make some kind of a move either within their company or by change of position so that they will be using their special talents for immediate war necessities. This probably means a considerable shifting about. Managements must expect to have to demonstrate to their personnel the war-time importance of the job if they are going to keep them.

Management officials also have the responsibility of appraising their need for additional technical personnel for the necessary war-time expansion of capacity or of research activities which are immediately pressing. Companies which have such prospective needs should make them known to the Manpower Commission and ask for the lists of those not on war jobs who might be sought as prospects to fill openings. The National Roster has quite a list of that sort which it may be able to use effectively in the assistance of process industry executives.

MORE CHEMICALS REPORTED ON LIST OF SCARCE MATERIALS

On Aug. 21, WPB issued its fifth provisional report on relative scarcity of certain materials. The materials are listed in three groups with group I containing the materials of which the supply is inadequate for war and most essential uses: group II lists those of which there are sufficient supplies for many essential needs; and group III represents the commodities which are in adequate supply for all appropriate types of present demands.

The listing of chemicals is as follows with those marked with an asterisk in the most critical position: Group I—*acrylonitrile, laurel alcohol, aluminum trihydrate, ammonia, ammonium cyanamide, ammonium sulphate, anthraquinone derivatives, arsenic trioxide, benzol, bleaching powder, *butadiene, butyl alcohol, calcium cyanamide, calcium hypochlorite, chlorosulphonic acid, cobalt chemicals, copper chemicals, *cresols, diphenylamine, glycerol, yellow hydrated iron oxide, lithium chemicals, mannitol, naphthalene, naphthenic acid, nitric acid, pentarythritol, perchloric acid, *phenol, tricresyl and triphenyl phosphates, phthalic anhydride, silica gel, sodium nitrate, sorbitol, sulphur chlorides, *toluol, urea and French zinc oxide.

Group II—acetic acid, acetic anhydride, acetone, amyl, ethyl and methyl alcohols, acrylic acid and acrylates, alkyd resins, aluminum chemicals, aniline, atabrine, bromine, butyl acetates, chlorates and perchlorates, chlorinated hydrocarbon solvents and waxes, chlorine, chromium chemicals, citric acid, ethers, formaldehyde, glycol, iodine, isopropanol, ketones, lactic acid and lactates, maleic acid, manganese chloride anhydrous, molybdenum chemicals, nickel chemicals, phosphorus, phosphorus oxychloride, phosphorus pentoxide, potassium permanganate, strontium salts, xylol.

Group III—aluminum sulphate, commercial, barium carbonate, borax and boric acid, camphor, caustic soda, chromic acid for plating, muriatic acid, nicotine sulphate, soda ash, sodium silicates, sodium silicofluoride, sodium sulphide.

LARGE ATTENDANCE EXPECTED AT CHICAGO CHEMICAL SHOW

Regarded as an important contribution of the chemical industry to the war-time effort, the National Chemical Exposition will be held Nov. 24-29 at the Hotel Sherman in Chicago. The Exposition had been originally planned for the Stevens Hotel but this was taken over by the War Department and the transfer to the Hotel Sherman provides adequate space for display of commercial and educational exhibits and also is readily accessible to the retail and amusement center of the city.

Victor Conquest, director of research for Armour & Co., who is chairman of the show committee, anticipates an attendance of approximately 20,000 from all sections of the country, including research chemists, executives of industrial plants, engineers, and government specialists. Mr. Conquest says this year's show will be twice as large in the number of exhibits and floor space as the first exhibition held two years ago and he added: "We are planning an interesting and momentous conference which will be in the nature of a forum. This parley will get underway at the opening and continue through the entire period of the show. A committee is now preparing a schedule of industrial motion pictures which will also add to the interest of the exposition from an educational standpoint."

RECORD OUTPUT OF SYNTHETIC ORGANIC CHEMICALS IN 1941

The Tariff Commission has issued a preliminary report on domestic production and sales of synthetic organic chemicals for 1941. Detailed statistics for coal-tar crudes, plasticizers, various pharmaceuticals, intermediates, and solvents are omitted to avoid disclosure of information that might aid the enemy.

The report shows that sales of all synthetic organics were valued at $724,000,000, an increase of 50 percent over the record sales of 1940. Sales value of coal-tar finished products and intermediates was 60 percent greater than in 1940 and sales of non-coal-tar synthetics 42 percent greater.

In the more important groups production increases in 1941 over 1940 were: intermediates 25 percent, dyes 32 percent, coal-tar medicinals 64 percent, coal-tar resins 50 percent, and all non-coal-tar synthetics 27 percent.

COLUMBIA CHEMICAL OFFICES MOVED TO PITTSBURGH

The executive sales office of the Columbia Chemical Division of the Pittsburgh Plate Glass Company has been moved to Pittsburgh from New York. E. T. Asplundh, vice-president, announced on Sept. 1. Also involved in the transfer are the chemical division's traffic and advertising departments. "The move," Mr. Asplundh said, "is a continuation of the company's program of co-ordinating its various divisions in the general office at Pittsburgh. Several years ago the executive office of the paint division was moved there from Milwaukee. W. I. Galliher, director of sales of the chemical division, will be in charge of sales activities from the new Pittsburgh headquarters.

News from Washington

WASHINGTON NEWS BUREAU, McGRAW-HILL PUBLISHING CO.

THESE are the weeks in which WPB is striving to gain mastery over the Frankenstein war machine which it has built. The machine needs oiling and it needs to have its gears meshed; to use Don Nelson's own term for it, the machine is out of balance. What has happened, according to Nelson, is that WPB has built, Topsy-fashion, a production machine without stopping to take time to look at the blueprint if, indeed, there was a blueprint. Fabricating capacity has been built faster than provision has been made to feed it. Some kinds of fabricating capacity have run amuck.

In many ways the situation could have been anticipated, perhaps was, by some. But it isn't likely that it could have been prevented and still have produced the plant capacity that has resulted, in so short a time. That's Nelson's battle stand in the midst of the angry fires which were built up around WPB in August. He would do it that way again, knowing the result. What has to be done now is to remove the creaks and groans of the big machine and get it running in some sort of orderly fashion—get it into balance. This is WPB's first problem after, as outlined on these pages in August, rounding the corner from the job of carving a war machine out of a peacetime industry to the assembly-line job of keeping that machine functioning on all cylinders.

WPB's approach has been one of tightening up the controls over the flow of materials through the Production Requirements Plan which actually is a form of allocation. For the fourth quarter of 1942, WPB is undertaking to obtain a realistic total of the stated materials requirements of the war factories, and of the supply which will be available to meet that demand. A sharp pruning knife treatment has been promised to insure that the PRP certificates doled out for fourth quarter use by industry not only keep within the supply but also trim the operations of the various components of production so that they will mesh among themselves.

Quinine Supplies

Present production of atabrine, the synthetic substitute for shut-off quinine supplies, is considered adequate for all foreseeable requirements, both military and civilian. The Army, Navy, Public Health and WPB all subscribe to that conclusion. It's the real reason behind the fact that the atabrine patent held by Winthrop hasn't been "nationalized," why only Merck has been licensed to produce the drug, a situation which stirred up a newspaper row in August and provided the Bone patent committee a new trial to follow.

The agreement of the interested war agencies on the sufficiency of atabrine production was obtained at the solicitation of the Alien Property Custodian who now administers General Aniline's 50 percent holdings in Winthrop but who has no control over the atabrine patent because it is (and always has been) American owned. Winthrop has agreed to license any competent producer any time the Government decides it needs more of the compound that it and Merck can produce.

Generally overlooked in the row over granting additional licenses for the compound is the fact that public health and the military medical men still are not ready for "all-out" substitution of atabrine for quinine. The synthetic product has a toxic effect on some people and the military has decided to use up the stockpile of quinine before resorting to the synthetic, hoping that in the meantime, the substitute can be improved.

Meanwhile, on the quinine front several steps developed in the direction both of getting as much increase as possible in supplies of the natural drug and in husbanding the stockpile in this country. A U. S. commission is leaving for Central America, especially Guatemala, to study the potentialities for increasing quinine raising. In August, also, the WPB Health Supplies Branch urged druggists having greater stocks of quinine, cinchonine, cinchonidine, and quinidine in excess of requirements to sell them back to suppliers for diversion to other druggists needing stocks or to the military. All sales of these commodities are under Order M-131 restrictions.

Vegetable Oils Subsidy

WPB has decided to subsidize the vegetable oil market in order to "bail out" Secretary Wickard and Leon Henderson whose promises to keep farm prices up and costs down could not live together. The first step was taken late in August when the Commodity Credit Corporation was chosen to carry out the plan and clothed in the mantle of WPB's full authority for the purpose.

CCC, already an old hand in the agricultural markets, needed only to look at how RFC was handling the similar oil problem on the eastern seaboard for its cue. Early in September the agency came up with plans for two products, cottonseed and linseed. Under the plan, Commodity Credit agrees to purchase vegetable oilseed and oilseed products from processors, refiners and bleachers who agree to pay at least a minimum price for oil crops, crude oil and linters.

This will support the price promised the farmers by Secretary Wickard when he asked for a bigger crop last fall. CCC will maintain OPA's price ceiling, however, by selling its purchases at a loss. In the case of cottonseed, peanut and soybean oil the loss will be a half cent a pound and the transactions will be limited to manufacturers of vegetable oil who pay designated prices for crude oil from crushing mills under contract with CCC.

Contracts with cottonseed crushers became effective on September 1, but purchases of 1942 cottonseed before that date are protected if the buyer maintained the supporting price. Contracts being made with linseed oil producers achieved the desired result but were geared to the established practices of the flaxseed market. Details of contracts to be offered peanut and soybean crushers, and to refiners of cottonseed, peanut and soybean oils were on the way in early September.

In the meantime there is speculation as to whether crushers will be asked to handle seeds other than those to which they are accustomed. Such action can hardly be avoided. The seed crop is 50 percent larger than it was last year and there has been no corresponding increase in crushing facilities. Some of the seeds will have to be shipped to the Pacific Coast to be crushed in the plants formerly handling copra and other seeds now cut off. The bright spot is that it is the avowed purpose of the agency handling the marketing program to see that the crop moves in an orderly fashion utilizing the existing trade agencies.

The illusion that Brazil production of vegetable oils and rubber can be stepped up sufficiently to be of any additional aid in the war effort was effectively dispelled by the report of the United States Vegetable Oil Mission to Brazil. The potential production capacity is there but there are other problems involved. One of the most serious is the labor problem—persuading natives to work when they have no need for money. The labor situation in northern Brazil effects not only harvesting of oil seed crops but rubber, lumber, and other agricultural products as well.

Synthetic Rubber

As is proving true with many items of war materials fabricating (copolymer) capacity for making synthetic rubber appears to be outstripping the construction of the component butadiene and styrene capacity in the government's program.

Perhaps this is the result of the bitter fight over whether to make butadiene from alcohol or petroleum, perhaps simply to a difference in time factors for building plant, but the fact seems clear, as shown in the "time table" for the synthetic rubber plant program printed on the accompanying page, that copolymer capacity is considerably ahead of styrene capacity, styrene ahead of butadiene.

The table also shows that this may be only a temporary situation. By mid-1943, the schedule calls for stepping up butadiene capacity to at least 450,000 tons annually—still a little out of balance with the 165,000 tons of styrene capacity scheduled by the end of June but virtually in harmony with the 500,000 tons of copolymer

Synthetic Rubber Time-Table*

Butadiene Plants

	Capacity tons	Completion Date
Carbide & Carbon	5,000	Sept. 1942
Standard Oil (La.)	6,200	Sept. 1942
Atlas Oil & Ref	12,000	Nov. 1942
Carbide & Carbon	20,000	Jan. 1943
So. Calif. Gas	25,000	Jan. 1943
Carbide & Carbon	20,000	Feb. 1943
Carbide & Carbon	20,000	Mar. 1943
Humble Oil	30,000	Mar. 1943
Shell Oil	30,000	Mar. 1943
Standard Oil (La.)	15,000	Mar. 1943
Carbide & Carbon	20,000	Apr. 1943
Carbide & Carbon	20,000	Apr. 1943
Neches Butane	50,000	Apr. 1943
Carbide & Carbon	20,000	May 1943
Carbide & Carbon	20,000	May 1943
Carbide & Carbon	20,000	June 1943
Carbide & Carbon	20,000	June 1943
Neches Butane	50,000	June 1943
Rubber Synthetics	50,000	June 1943
Carbide & Carbon	20,000	July 1943
Cities Service	55,000	Aug. 1943
Koppers United	20,000	Aug. 1943
Rubber Synthetics [1]	50,000	Aug. 1943
Sinclair Rubber	50,000	Oct. 1943
Total	648,200	

Styrene Plants

Monsanto	10,000	Oct. 1942
Carbide & Carbon	12,500	Jan. 1943
Dow Chemical	4,200	Jan. 1943
Monsanto	10,000	Jan. 1943
Monsanto	10,000	Feb. 1943
Dow Chemical	25,000	Mar. 1943
Monsanto	5,000	Mar. 1943
Carbide & Carbon	12,500	Apr. 1943
Dow Chemical	25,000	Apr. 1943
Dow Chemical	25,000	June 1943
Dow Chemical	25,000	June 1943
Dow Chemical	12,500	Aug. 1943
Koppers United	35,000	Aug. 1943
Total	211,700	

Copolymer Plants

Goodyear	15,000	May 1942
Firestone	15,000	June 1943
Goodyear	15,000	Aug. 1943
U. S. Rubber	15,000	Aug. 1942
Firestone	15,000	Sept. 1942
Goodrich	30,000	Nov. 1942
U. S. Rubber	15,000	Nov. 1942
Goodrich	30,000	Jan. 1943
U. S. Rubber	30,000	Jan. 1943
Firestone	30,000	Feb. 1943
U. S. Rubber	30,000	Mar. 1943
Goodrich	30,000	Apr. 1943
Goodyear	30,000	Apr. 1943
Goodrich	15,000	May 1943
Goodyear	15,000	May 1943
U. S. Rubber	30,000	May 1943
Firestone	15,000	June 1943
Goodrich	10,000	June 1943
Goodyear	30,000	June 1943
Goodyear	10,000	June 1943
U. S. Rubber	15,000	June 1943
Open	30,000	June 1943
Open	30,000	June 1943
Firestone	15,000	July 1943
U. S. Rubber	15,000	July 1943
Firestone	15,000	Aug. 1943
Firestone	60,000	Aug. 1943
U. S. Rubber	15,000	Aug. 1943
Open	25,000	Aug. 1943
Goodyear	55,000	Oct. 1943
Total	700,000	

Butyl Plants

Standard Oil (La.)	7,000	Nov. 1942
Humble Oil	20,000	July 1943
Standard Oil (La.)	33,000	July 1943
Total	60,000 [2]	

Neoprene Plants

duPont	10,000	Oct. 1942
duPont	10,000	Apr. 1943
duPont	20,000	Oct. 1943
Total	40,000	

[1] This plant will not be completed but this capacity is being reallocated to other plants on the list. [2] This total has been increased to 132,000 tons by expanding existing plants.

* This compilation made by the Rubber Reserve Corp. gave the status of the synthetic rubber chemicals program as of July 15. At the American Chemical Society meeting in Buffalo on Sept. 9, it was announced that the current program for butadiene production calls for an annual rate of 717,800 tons to be reached in Oct. 1943.

The Baruch committee report of Sept. 10 recommends additional annual capacity of 100,000 tons of butadiene, 20,000 tons of neoprene, and enlarged capacity for styrene and polymerization plants, and immediate construction of alcohol plants to produce 100,000 gal. a year.

capacity due to be ready at that time. Figures for 1942 year's end are 120,000 tons of copolymer capacity, to 10,000 tons of styrene and 23,000 tons of butadiene.

In the relative unbalance of the components of the program can be found at least partial answer for the Government's decision late in August to abandon the projected 50,000-ton butadiene plant planned to start operations in Gary, Ind., next August under Rubber Synthetics' management. Other plants are to be stretched to handle this production, and to get it underway more quickly. There was talk in early September that the United Koppers plant of 20,000 tons at Pittsburgh, also due in August, 1943, might be reallocated for the same reason, but this appeared unlikely.

As of early September, the Baruch committee named by the President to "umpire" the whole rubber tangle was, of course, still to be heard from. There appeared little likelihood, however, that this committee would recommend upsetting much of the plant program now underway—for the simple reason that this can hardly be done if the goal of an 800,000-ton capacity is to be reached by the end of 1943. It was generally expected that at least the "feature attraction" of the Baruch report would be designed to sell the public on the facts of the rubber shortage and pave the way for public acceptance of stricter regulations, perhaps including national gasoline rationing.

Priorities System

Among the flood of minor and major alterations in the priorities system which have been put into effect by WPB are two which materially affect chemical operations.

As a substitute for the time-consuming PD-25F form, a chemical company operating under the Production Requirements Plan can now wire to the WPB chemicals branch maintenance and repair unit for relief on breakdowns. Necessary information includes the name and address of the company, address of the receiving plant, description and quantity of material requested, suppliers' statement on date of delivery with a specified rating, purchase order number and value, name and address of supplier, description of the end production and its relation to the war program or to public health. The applicant's serial number and priority order under which it is operating, reason for need to make such application also are required. Relief from breakdown of capital equipment also can be handled by the unit in the same manner.

Exemption No. 2 to Priorities Regulation No. 11, permits companies operating under PRP to purchase a number of commodities in greater quantities than authorized on their PRP certificate. Materials on the "free" list are all those not listed on Materials List No. 1 as revised and all those exempted from inventory restrictions by General Inventory Order M-161. Bulk of the chemicals are in one of these two categories, which means that purchases of such items in excess of PRP percentage authorizations are permitted up to the availability of supplies—but, of course, still subject to the use restrictions applicable to many individual chemicals in the various "M" orders.

Changes in Chemicals Branch

Changes in personnel and organization of the Chemicals Branch of WPB were made at the end of August. Lawrence Brown will coordinate the work of the five sections and will have the title of Assistant Branch Chief. Hugh D. Hughes of Carbide & Carbon Chemicals Corp., becomes Chief of the Aromatics and Intermediates Section to replace James Reynolds who is now Assistant Chief of the Chemicals Branch. Donald C. Knapp of George Mann & Co., heads the new Transportation and Packaging Section which has been set up within the Chemicals Branch and Frank Carman of Armstrong Cork Co., is in charge of a new Plastics and Synthetic Rubber Section which replaces the two sections heretofore operating separately in these fields. Arthur Petersen becomes Chief of the Products Advisory Section.

Research on Charcoal

One hundred pounds of coconut-shell charcoal present a surface area of approximately 30 square miles. Corresponding figures for a sample of new bone char are two square miles per 100 pounds. These surprising values have been obtained by research associates of the cane sugar refiners and bone black manufacturers working at the National Bureau of Standards. They have been studying the surface areas of carbonaceous adsorbents, particularly the surface available to nitrogen on bone blacks, activated carbons, vegetable carbons, and coconut charcoals.

The usefulness of these porous materials as adsorbents in various refining processes depends principally upon the extent of their surfaces and upon the accessibility of those surfaces to the molecules that are to be absorbed. The surface is generally much greater than the apparent surface, and, obviously, parts of it may be accessible only to small gas molecules; in fact such minute units are the only thing that can serve as a measuring standard if the total surface is to be determined. In the recent Bureau investigation, the method used depends upon the adsorption of nitrogen at low temperatures. This was determined by measuring the pressure decrease of a known volume of the gas exposed to a sample of the material. The specific surface was deduced by analyzing these data with the aid of the multi-molecular theory of adsorption.

Alcohol Production

While the date on which the production of hard liquor is to be stopped and the remaining facilities converted for the production of alcohol has been

tentatively set for November 1, there is reason to believe that there will be no wholesale conversion at that time. Yet, the industry is going ahead as if November 1 would see the last of the whiskey production for the duration. The basic reason for this approach is that no one knows how much alcohol the war program is going to need. No one can tell how much will be required for rubber or for smokeless powder. And the production picture still is not entirely clear. No one can tell how much molasses will be shipped in from the sugar islands. This in turn depends upon how many ships are lost through enemy action or possibly on the number of tankers that are allocated to that service by the strategists. But there seems to be one thing that is almost certain in the alcohol picture: Breweries will not be converted. And this again is a shipping problem. Breweries as a rule are not on railroad sidings.

CHEMICAL WARFARE SERVICE NEEDS CHEMICAL ENGINEERS

Chemists and chemical engineers who want to join in the war effort possibly in a more direct manner than they are at the moment have an opportunity to do so. The Chemical Warfare Service is in need of experienced men. However, the emphasis is on older men with actual plant experience rather than recent graduates who have only technical training to offer. Applications can be made by writing to the Chief of Chemical Warfare Service, attention of the Chief of Personnel, Washington.

Construction of the CWS Rocky Mountain arsenal is underway. Families have been moved out of the area and actual building operations have commenced. Col. Charles E. Locks is the commanding officer. He was formerly the executive officer in the office of the chief of Chemical Warfare Service.

The Alabama arsenal, meanwhile, has gone into production well ahead of schedule. Procurement of material in anticipation of accelerated construction schedule enabled plant operations to begin as soon as the equipment had been installed in the buildings. The prior training of production line employees also was helpful in getting operations underway and increased the production on one line 50 percent above expectations.

A new joint committee has just been appointed to direct and to coordinate all the research and development work of the Chemical Warfare Service and the National Defense Research Committee's technical committee. Col. William C. Kabrich, chief of the Technical Division of CWS is the chairman. Members of the committee are: Dr. James B. Conant, president of Harvard University, and chairman NDRC, Dr. Roger Adams, University of Illinois, chairman of Division B, Dr. W. A. Noyes, Jr. director Department of Chemistry, University of Rochester, Col. Martin B. Chittick, chief of the Engineering Branch Technical Division CWS.

RESEARCH LABORATORIES MUST FILE PRIORITY FORMS

Research laboratories which put into process $5,000 or more worth of metals quarterly must, like production plants, file their priority certificates under the Production Requirements Plan in order to get materials to continue operations in the fourth quarter, WPB has ruled. Special instructions for the use of research, analytical and testing laboratories in filling out Form-PD-25-A—the PRP application form—have been drafted by the Safety and Technical Equipment Branch to take cognizance of the problems of laboratories in estimating requirements of most materials and fabricated parts. These instructions are available in the form of release T-712, from the above mentioned branch and from WPB field offices.

CHEMICAL INDUSTRY URGED TO AID SCRAP SALVAGE PROGRAM

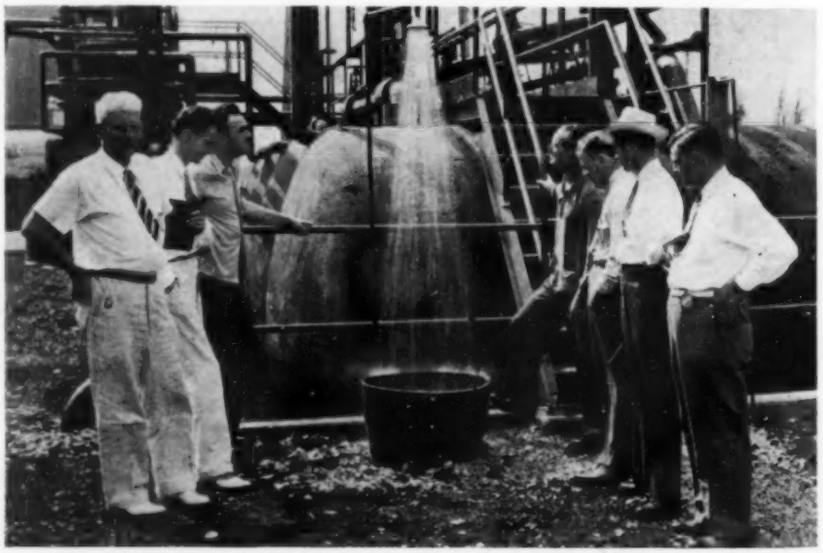
W. S. Carpenter, Jr., president of E. I. du Pont de Nemours & Co. is participating in the work of the American Salvage Committee to enlist full cooperation of individual industrial concerns behind the current scrap salvage program of WPB. Serving as liaison between the committee and companies in the chemical industry, Mr. Carpenter has written the individual companies urging their full cooperation and asking each company to appoint a responsible official to assist in any way possible the local general committees that have been established in 12,000 communities.

In his letter Mr. Carpenter wrote: "They have asked me to help organize the chemical industry—every company in our industry—to get behind the efforts of the War Production Board. This is a situation wherein by helping our Government we are also helping ourselves; because industry cannot do a satisfactory job of production without more scrap materials than are normally available. It has been standard practice with most of us to care for our 'production scrap' but now something is needed beyond that. There is needed an extraordinary cleanup of our factories, involving recognition of the fact that if a machine or pipe line, a heating plant, a building—or what have you—is not absolutely essential for production at this particular time, then consideration should be given to scrapping it. If we don't win this war, most of our factories will be scrap anyway."

WEST VIRGINIA WILL DEDICATE NEW INDUSTRIES BUILDING

As a fitting tribute to the opening of the institution's seventy-sixth academic year, West Virginia University, Morgantown, W. Va., on Oct. 16 and 17 will dedicate its new million-dollar Mineral Industries Building. Begun in 1940 the building is now fully completed and equipped. It will house the School of Mines, the West Virginia Geological Survey, the Department of Geology, and the Department of Chemical, Metallurgical, and Ceramic Engineering.

Dr. Friend E. Clark, chairman of the University Graduate Council and head of the Department of Chemistry is chairman of the dedication committee. Speakers will include Governor M. M. Neely and Charles E. Lawall, president of the University. Addresses also will be given by Dr. George O. Curme, Jr., vice-president of Carbide & Carbon Chemicals Corp. and Sidney D. Kirkpatrick, editor of *Chemical & Metallurgical Engineering*, representing chemistry and chemical engineering.



During the inspection of the Trenton plant, members of the first annual Monsanto Safety Conference try out a newly installed safety shower. Left to right: W. W. Stephen, Phosphate Division safety engineer, Anniston, Ala.; James Baker, safety engineer, Norfolk, Va.; A. N. Allen, personnel manager, Monsanto, Tenn.; P. T. Bricker, personnel manager, Nitro, W. Va.; Alvin Queen, personnel manager, Karnack, Texas; T. D. Tucker, personnel manager, Trenton, Mich.; and George L. Lero, safety engineer, St. Louis.

SOLVED—
the mystery of the fuming nitroglycerine

One of a series of cases from the files of Monsanto's Technical Service Department which show how skill, experience and ingenuity can solve many critical wartime production problems. For obvious reasons names and any identifying clues have been omitted.

1. "There must be something wrong with that car of mixed acid you shipped our new plant at XXXXX. When we run a finished nitration batch into our drowning tank the stuff sends up clouds of dense, reddish fumes and almost boils over the sides of the tank. My men are so scared they're ready to quit—and the plant is practically shut down."

The customer, a manufacturer of nitroglycerine was worried, excited—and mad!

2. That was 5 o'clock on a Friday afternoon. Immediately tests were re-run on the control sample from that particular batch of acid. The plant man who loaded the car was called from his dinner and questioned closely on the possibility of any contamination during loading or in the car. The acid was definitely cleared of all possible suspicion.

But at nine o'clock that same evening the customer was told by phone, "We're sending a man from our Technical Service Department tonight."

3. At the customer's plant every possible check was made—on the water supply, even on the thermometer used to control temperatures in the drowning tank. A sample batch of nitroglycerine was run into the tank—and the mystery was solved.

Like the rest of the plant, the tank was new. Resin, from the yellow pine staves with which it was built, was reacting with spent acid run into the tank with the explosive. As the wood aged, the fumes would subside.

The men were satisfied. The plant resumed production.

4. When Monsanto Technical Service men investigate a complaint, they search for more than an acquittal for the product involved. They aim at *a solution of your problem.* And three factors often give them a head start: (1) an understanding of *your* basic processes; (2) a broad knowledge of their own business which springs from the very breadth and variety of Monsanto's chemical experience; (3) and years of individual training in solving problems by observation, analysis and deduction. For their help *on any project that will help win the war,* inquire: MONSANTO CHEMICAL COMPANY, St. Louis.

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"E" for Excellence . . denoting the highest service accomplishment of the United States Navy . . . flies over Monsanto "in recognition of production of ordnance material vital to our national defense." In addition to the Ordnance flag and "E" pennant, Monsanto has now been awarded the All-Navy "E" burgee, at left, "for excellence in war production."

GREAT BRITAIN FURTHER RESTRICTS USE OF RUBBER, TIN, AND OTHER FAR EAST PRODUCTS

Special Correspondence

More stringent restrictions have been imposed on the use of tin, rubber and other commodities from the Far East for which new sources of supply have to be developed, and their combined effect on demand will no doubt be considerable. Meanwhile, private efforts for the establishment of more extensive substitute industries in the British Isles continue. The authorities are, broadly speaking, not in favor of the erection in wartime of large substitute plants requiring substantial investments of materials and labor. The problems of coal-oil production are still actively investigated by the Department of Scientific and Industrial Research, but nothing is known of new commercial developments. Representatives of the Ministry of Supply have attended a conference in the United States to investigate the possibility of speeding up the production of synthetic rubber, but the Government's advisers still maintain that even after making full allowance for the co-products made, less shipping space is required for importing finished synthetic rubber than for crude oil subsequently to be cracked and otherwise worked up into butadiene.

Chemical engineers who thus see their hopes for a synthetic rubber industry in England disappointed, at least for the time being, are faced with new problems arising out of the extensive utilization of reclaim. Systematic research into the suitability of reclaim for compounding agents used for crude rubber has shown the possibility of certain economies. In a crude-reclaim mixture which contained 50 parts reclaim, 42 parts smoked sheet, 5 parts zinc oxide, 2 parts sulphur, etc., the effect of the various compounding ingredients was similar to that produced in non-reclaim mixtures. Calcene and anhydrous calcium sulphate had the most marked accelerating effect on the cure and the latter may be studied with a view to its use as a substitute for whiting, barytes and French chalk. If half the crude rubber is replaced by reclaim, the amount of accelerator can be reduced by 25 percent or more, or it may be preferred to retain the original proportion of accelerator and reduce the sulphur content.

A rubber cement of 100 parts of rubber dissolved in a mixture of 70 parts of benzene and 300 parts of dichlorethylene is recommended by the British Rubber Publicity Association. The addition of 10 parts of ester gums greatly increases the adhesive character of such a cement, and the further addition of a very finely divided carbon black—between 20 and 40 percent of the rubber—gives a strong, reinforced film and better bonding.

British paper mills have pooled their knowledge to develop the most suitable alternatives to rosin for sizing, as all supplies of the material must be imported, mostly from the United States and to a smaller extent from Portugal. Among substitutes and extenders which have been found promising are an argillaceous mineral, soft coumarone resins (the production of which in the British Isles began only during the war), paraffin wax emulsions, starch and sodium silicate. Most of these materials are proposed for use as extenders only, but the saving of rosin may be considerable. Among substances suggested for the complete replacement of rosin are tree bark oil soap, ordinary rosin-free soap, cellulose mucilage, rubber latex, seaweed extract, blood albumin, Irish mosa, beeswax and montan wax. For one reason or another none of these has proved satisfactory, and experiments with synthetic phenolic resins, polymerized or oxidized vegetable oils, and vulcanized rape, castor and maize oils were also at best inconclusive. On the other hand, it has been proved that stearic acid or naphthenic acid can take the place of rosin. Rosin extenders now being used on a commercial scale are colloidal clay, specially made for the purpose, and petroleum resin emulsions which are used in a 25:75 mixture with rosin. A sizing emulsion entirely free of rosin which is now produced in large quantities contains 37 parts actual petroleum resin, 18 parts colloidal clay, 1 part alkali and 1.2 parts casein.

The Irish Industrial Research Council has given much attention to the chemical utilization of seaweed. A product prepared from it was found to be a satisfactory alternative to sago flour in the sizing of twine and may also serve as a substitute for starch. It is hoped to produce water-proofing agents and plastic materials from algin, and alginate films and filaments promise to be a valuable material. Ethyl alcohol has been obtained from seaweed in the laboratory, the yield being equal to 13-17 gallons of alcohol per ton of air-dried autumn weed. After extraction of the salts, the seaweed yielded a board with good appearance to which nails and screws could be fixed. All these developments are still in the experimental stage, and nothing is known about their economic value.

British farmers used to cultivate 16,000,000 acres of land before the war. Today the area under the plough is 5,250,000 acres larger, and while important changes have taken place in the selection of crops, the demand for chemical fertilizers has risen to the same extent and more. But as phosphatic and potassic fertilizers must be imported, largely over wide distances, these are no longer distributed except under permit from the County War Agricultural Committees and Ministry of Supply license for immediate use. The prices for ammonium sulphate, superphosphates, ground phosphates, and compound fertilizers will remain unchanged during the 1942-43 season, although the British producers of ammonium sulphate are faced with somewhat higher costs of production. As far as agricultural lime is concerned, there have been local shortages of certain kinds, but the great bulk of the orders placed by farmers will be delivered before the autumn ploughing begins though farmers may occasionally have to accept delivery of alternative kinds of lime. No guarantee for the supply of particular types of lime in particular areas is given. The reason of this is to be found in the field of transport. As the railways and coastal shipping have to carry heavy loads of other materials, fertilizers and heavy chemicals generally are now distributed in such a way as to cause minimum claims on transport.

The formation of a new Ministry of Fuel and Power draws attention to one section of the fuel manufacturing industry which is closely connected with the chemical trades. The carbonization works and gas plants have had to accept a large measure of official direction, not only in the choice of coals to be used but in the production and sale of byproducts. It is expected that this part of their business will grow in importance in the future, and the increased market for liquid byproducts may enable the coke-oven works to extend their output to such an extent that the bulk of the gas required in the British Isles—apart from districts so remote from the coal fields that transmission of gas would become too expensive—can be secured from coke ovens. This seems to be the opinion of those responsible for the war direction of the coke and gas producing works, but it is realized that a great deal of rebuilding will be necessary in coke ovens after the war. One proposal is that the coke ovens should be rebuilt on the combination principle and heated by producer gas generated from high-ash coal produced as an intermediate product in coal washeries. This would make it possible to supply a large fraction of really clean slack for coking so that low-ash coke could be produced. By using producer gas for all purposes where coke-oven gas is now being used the quantity of coke-oven gas available to the gas industry could be organized regionally. It would probably be best to organize the whole country into five or six self-sufficient gas regions.

This and similar proposals are of special interest to chemical engineers because coal is the only raw material of organic chemistry which is available in the British Isles in really large quantities. All future developments in the organic chemical industry will be based primarily on coal, and it is believed that considerable quantities of valuable starting materials for chemical processes can be made available without reducing the quantity of basic commodities like coke, gas, boiler fuel.

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The seal shown below now protects every General Chemical Company tank car shipment. Customers receiving tank cars without these seals, or with seals broken, should analyze the material before it is used.

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BASOLIT Cement is saving time and speeding work —wherever acid-proof construction is required— in Chemical process plants, Steel and Galvanizing plants, Oil refineries, etc. It is also used extensively as an insulator cement in Electrical installations and is an excellent casting compound for Die-casts and Forgings. Basolit is also and especially adapted to jointing sewer and water pipes.

Manufactured in three grades, Standard, Carbon and Plasul, BASOLIT Cement is a thoroughly homogeneous, non-porous, sulphur compound of low specific gravity (about 2), unexcelled in evenness and density. Contrary to most other acid-proof mortars, BASOLIT does not require days for setting but *hardens a few minutes to an hour after application* and is then ready for use.

BASOLIT will adhere solidly to any rough surface of stone, cement, masonry and to itself.

It has a compressive strength of 7000 lbs. and a tensile strength of about 700 lbs. per sq. inch.

BASOLIT will keep indefinitely; can be stored anywhere without deterioration in substance and quality. It is shipped crushed in 100 lb. burlap bags or solid in 400 lb. drums.

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(A) Basolit-brick lined storage tanks for hot sulphuric acid

(B) Basolit-brick lined acid-proof floor.

Standard Basolit, a sulphur silica compound, has high density, evenness, and low specific gravity. Used for grouting foundations and anchor bolts. For quick repairs of defective machine or crane foundations.

Carbon Basolit—a sulphur compound similar to Standard except that it is immune to hydrofluoric acid—specially suited for use with carbon brick in hydrofluoric pickling tanks.

Plasul Basolit—Plasticized sulphur (made under license of Texas Gulf Sulphur Co.) has same characteristics as Standard and Carbon plus the properties for adaption to uses requiring high thermal and mechanical shock resistance. Immune to all acids except Chromic. Does not shrink, swell, warp nor crack under temperature or atmospheric changes. Ideal for die-casts and patterns.

BASOLIT is immune to:

Concentrated or diluted; hot or cold . . .

Sulphuric Acid
Hydrochloric Acid
Acetic and Lactic Acids
Nitric Acid (30% solution)
Sodium Chloride
Ferric Chloride
Ammonium Chloride
Ferro Sulphate
Ammonium Nitrate
Copper Sulphate
Ammonium Sulphate
Sodium Chlorate
Sodium Thiosulphate
Sodium Phosphate
Potassium Chromate
Potassium Bisulphate
Zinc Chloride
The Sodium Bisulphates
Etc.

Basolit is not immune to Chromic acid, strong alkali solutions and most of the hydrocarbons. Send for complete details.

Nukem

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etc., if the coal is treated beforehand with a view to the extraction of those ingredients which are more useful chemically than were they allowed to be burned as fuel. From the point of view of the chemical industry the present use of virgin coal as industrial and household fuel is very wasteful, and it is hoped that industrial developments after the war will reduce the waste of valuable ingredients.

Although oxalic acid is one of the chemicals which have occasionally been in short supply, its popularity with textile manufacturers has not suffered during the war. Additions of 1-2½ percent of oxalic acid to solutions of aluminum sulphate and tartar emetic are used for the preparation of mordant on wool before applying alizarine red dyestuffs; 3-5 percent are added to alum solutions for the aftertreatment of textiles dyed with alizarine reds, yellows and oranges; 2-3 percent are added to solutions for logwood and naphthylamine-type acid blacks, 3-4 percent to sumac combination blacks, 2½-3 percent are used for chrome mordanting to assist the reducing action of the wool itself. Oxalic acid solutions of 3-6 percent are used for stripping shoddy with bichromate and sulphuric acid, 2 percent solutions are used to make cotton goods tender, small additions of ammonium oxalate are used for correcting hard water before dyeing with some black dyestuffs. Yorkshire and Lancashire methods of using oxalic acid for rinsing tanned cotton goods to remove iron dulling is applied to dry cleaning by use of potassium permanganate followed by oxalic acid for removing stains. One ounce each of oxalic acid and acid potassium fluoride in a quart of water are used for removing rust stains. There are similar uses for salts, especially tin and potassium antimony oxalates, and while these are limited to a small field, oxalic acid is recognized as so valuable that no substitute has yet found favor in English textile mills.

CHEMICAL ENGINEERS SOUGHT FOR WAR WORK

Chemical engineers experienced in plant layout and design, or in production control, in heavy-chemical or allied industries, are urgently needed in connection with ordnance and chemical warfare work. The Civil Service Commission is recruiting men with such experience, or in any phase of chemical engineering, for positions paying from $2600 to $4600 a year. Vacancies exist in important war projects both in Washington, D. C. and in the field.

Qualified persons are urged by the Commission to apply at once. The forms may be obtained at first- and second-class post offices throughout the country. There is no written test, applicants being rated upon the basis of their education, experience, and record of accomplishments. Applications should be sent to the Commission's Washington office and will be accepted until the needs of the service have been met.

GERMANY SETS UP TRUST AND OPERATING COMPANIES FOR CHEMICAL INDUSTRIES IN OCCUPIED AREAS

Special Correspondence

EDITOR'S NOTE: *Cut off from direct correspondence with all except a few foreign sources in neutral countries, these notes interpret recent developments in continental Europe as reported in publications and official documents received in the United States. These monthly letters, prepared in this country, will be continued only so long as pertinent material of interest to American chemical industry is available for our comment and interpretation.*

GERMAN operation of the chemical industry in eastern occupied areas is assuming a more discernable pattern than in western Europe where the complex corporate structure being built up will be hard to unscramble after a Nazi defeat. When Poland was overrun, important state-owned plants like the Moscice-Chorzow nitrogen units were taken over and put into the huge Hermann Goering concern. In Russian-occupied territories state ownership of plants has made transfers relatively simple.

In Poland, where a considerable part of the industry was foreign-owned, some private transactions have occurred. In some cases since the foreign owners are in German occupied areas or since German firms were jointly interested before the war, all plants have not changed hands. A recent important transaction was the purchase by I. G. Farben of the Boruta Chemical Industry Co. at Lodz (now Litzmannstadt). Renamed Teerfarbenwerke G.m.b.H., the plant is to be modernized and expanded to produce textile chemicals in addition to dyestuffs.

Of more significance, however, is the new large-scale pattern emerging with the establishment not only for Poland but for other eastern territories of two types of companies, so-called "Betreuungs-Gesellschaften" (trust companies) and "Betriebsgesellschaften" (operating companies). The latter group includes Baltische Oel A.G., Ost-Oel G.m.b.H., Bergund Huettenwerks Gesellschaft Ost m.b.H., and Ostfaser G.m.b.H. These companies are to exploit local resources of shale oil, mineral oils, minerals, and fibers. The trust companies are designed to line up whole industries. New companies are the Soda und Aetzalkalien-Ost Gesellschaft, Chemie-Ost Gesellschaft, Stickstoff-Ost Gesellschaft, Superphosphat-Ost Gesellschaft, and Seifen- und Waschmittel Ost Gesellschaft. The latter group is to supervise factories, labor, and raw materials for the soda and caustic alkalies, chemicals, nitrogenous compounds, superphosphate, and soap and washing agents industries.

It is not clear from German press announcements whether these eastern companies are designed primarily for Baltic and Polish enterprises or whether they are to include Russian state-owned industries. Last winter when Alfred Rosenberg was appointed minister for Russian-occupied territory, many bureaus were set up to arrange for resumption of work in mines and factories. The Ost Oel Gesellschaft was reported, for instance, to be ready to handle Caucasian oil if and when German troops captured these areas.

In occupied territories, as well as in the Reich, a large-scale census of machinery and plants is being taken to see where transfers of machinery and plants are feasible. This probably does not mean a wholesale transfer of plants to other areas as to Norway, where several long-planned Norsk-Hydro and I. G. Farben electrochemical and other chemical plants are now under construction. Wholesale transfer of plants would not be made unless raw materials, labor, and transportation facilities were readily available in areas considered "safer" from the bombing standpoint. Nevertheless, the Reich's production problems are admittedly growing. The length of the war is beginning to tell in depreciation of machinery and plants, and breakdowns are reported to be more frequent. Sufficient spare parts are not available since it was expected that the war would be shorter, and German plants have been running on virtually a wartime basis for nearly a decade.

In order "to mobilize all available resources and to utilize them to the best effect in the service of the state," on June 16 Hitler created a scientific research council, headed by Hermann Goering. In this connection, German scientists are admonished that "pure" research is out and that they must devote their whole research to problems directly concerned with the war effort.

Considerable research has been carried on to overcome the deficiency in lubricating oils. In France present production based on anthracenic oils is not satisfactory, and experiments are being made with mixtures of castor and other vegetable oils, including a new type from fir which is being tried out by the French State Railways. In Germany, residual oils from lignite carbonization have not been too successful. Heavy tar oils have been distilled, but their high acid and sulphur content has been a disadvantage. Repeated distillation of shale oil and treatment with sulphuric acid and subsequent fractionation is reported to have yielded a fairly satisfactory lubricant.

Substitutes for imported oils for the paint industry have been a headache for the past decade. Castor oil is used extensively in various parts of Europe as a substitute for tung oil. Castor bean plants are cultivated on a larger scale throughout the Balkans, where plantings, the supplying of seeds, and fertilizing are carried out under supervision of German experts. After dehy-

New *Heatless* Method of Purifying Water

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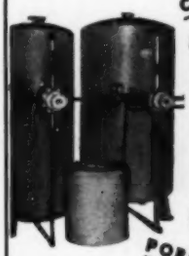

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1,000 gallons for less than a dollar!

LOW COST — The cost of the treated water is amazingly low — *less than a dollar per thousand gallons,* on the average water supply. And when the supply is low in dissolved solids, the cost may be considerably less.

No heat used—No fuel required!

Operation is completely automatic (between periodic regenerations). Pipes will not lime up. Maintenance costs are reduced to a minimum. A unit delivering 300 gallons an hour occupies a space about 4 x 10 feet. Made of finest materials to protect the purity of water. Available in units affording from 120 gallons an hour to 50,000 gallons an hour.

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MEETING the need for supplying lubricating oil at desired uniform pressure to lantern glands of stuffing boxes. Also supplies lubricating oils to Double Dura Seal installations. It has a dependable new type pressure regulator adjustable from zero to 1000 lbs. Comes complete with cooling device and filter. Electric motor or turbine driven. Standard sizes supply 1 to 8 stuffing boxes.

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dration and other treatment, castor oil is used as a plasticizer in the lacquer industry and for alkyd resins in addition to serving as a substitute for tung oil.

As a substitute for linseed oil, Germans are collecting grape seed residues from wine-making. The first oil pressed from grape seeds is made into edible oils, and only the second oil processed is used in the soap and paint industry. Although paints using grape seed oil have a higher viscosity and dry slower they are claimed to be more resistant to sunshine and high temperatures.

Europe's potential capacity for producing grape seed oil will, of course, not go far to supply the oil deficiency. Optimistic estimates place possible production at 60,000 tons after several projects are carried out. Germany is only a newcomer in the field, having started in 1937, and present output is around 1,500 metric tons a year. Italy has been at it longer, and her output is about 10,000 tons. Spain has just started developing such an industry and expects to turn out 5,000 tons a year soon, and Balkan countries, chiefly Serbia, are planning to undertake production in the near future. In place of linseed oil used in the manufacture of linoleum, one Italian producer has substituted a gum resin reported to be manufactured from tomato skins, while the jute backing has been replaced by cell wool.

Luminescent blackout paints also have presented problems as imported ingredients are no longer obtainable. In Germany zinc sulphide paints are still used for signs and other places where special visibility is required. Zinc, it will be remembered, is not one of Germany's scarce materials since the addition of Polish Upper Silesian zinc production to that of the Reich. It is too expensive, however, to be used for covering large surfaces. A white lithophone paint has been developed which is claimed to be economical and to give sufficient afterglow for four hours after lights are turned off.

As a paint to protect iron work against rust, barium nitrophthalate is used in Germany. It is stated to be satisfactory even in aqueous emulsions, and its covering power, it is claimed, can be increased by adding suitable dyes or pigments. Primary coats for iron and steel for which imported lead pigments have been used heretofore are made from a finely ground alloy of 87 percent aluminum and 13 percent silicon, both plentiful ingredients in the Reich. It is said to be suitable for all purposes and to have satisfactory adhesive and elastic qualities even when synthetic resin binders are used. Experiments have been made with the pigment in primary coats which do not contain any linseed oil at all, and in covering coats with only 5.8 percent linseed oil. Tested for several years by the Reich Bureau of Standards and the State Railways, the largest paint user in Germany, the new pigment is claimed to be as good as lead pigments, and its enthusiastic backers predict it will be

able to compete after the war is over.

To expand and improve processes of magnesium production, the Studien Gesellschaft fuer Metallgewinnung A.G., a joint subsidiary of I.G. and the Deutsche Magnesit A.G., has conducted research with Austrian magnesite deposits. A new million RM company Suedost Magnesit G.m.b.H., recently was formed by leading German and Austrian producers to establish, lease, and operate magnesite plants.

In connection with the increased amount of magnesium handled in German industries, it is reported that measures are being taken to safeguard workers against chemical gas gangrene caused by magnesium and some of its alloys. The ailment is reported to be similar to gas gangrene, only it is caused by magnesium particles instead of germs getting into the wounds and producing the unique gaseous condition if all wounds and cuts are not completely cleaned out. In 1939 there were over 5000 cases of this type treated in German industries.

A growing shortage of common medicinal products is reported by neutral visitors leaving Germany. Aspirin, narcotics, and other pharmaceuticals normally easily obtainable, are in some cases sold only against prescriptions. Tincture of iodine, for instance, can be obtained only on a specific order signed by a doctor and is dispensed in more dilute form than is called for by the German Pharmacopœia. Tincture of iodine is being replaced by a five percent solution in alcohol of chlorated alkylated phenols in conjunction with quarternary ammonia salts for some uses. As iodine stocks get lower, processes are being devised to recover more iodine, especially from photographic processes.

As a substitute for gum arabic, agar agar, and tragacanth, sodium cellulose glycollate is used increasingly in the Reich. It is produced in a wide variety of forms in six plants in Germany. Cellulose esters with low viscosity are used for sizing and dressing in the textile industry. Preparations of medium and high viscosity are employed as emulsifiers, binding agents in the paint industry, and adhesives, and sodium cellulose glycollate is expected to be utilized in the food industry.

Because of resistance to moisture and chemicals, the polyvinyl chloride, "Igelit," in paste form is being applied with suitable plasticizers to protect textile fabrics. It cannot be used to treat woolen materials because of high temperatures necessary, but has been successfully applied on cotton, viscose rayon, and jute fabrics.

In the textile and paper field, a recent development has been the organization in Berlin of a new company, Faser Chemie G.m.b.H. Its purpose is "the purchase and development of chemical and technological processes for the production of cellulose and paper." It is believed the company will take over German rights of various Scandinavian patents for use in the Reich cellulose industry.

4

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No matter what type of piping system your plant-extension program may call for . . Grinnell's complete range of piping services and products offers short-cuts to a better installation! Here are four time-savers for *you* . . . four of many Grinnell products that are clipping months or minutes off today's war construction schedules involving piping.

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WHENEVER **PIPING** IS INVOLVED

half of the steel you'll get next year

is lying around as SCRAP today!

You might be astonished at the amount of the scrap you'd find on a careful tour of your own plant this very minute!

Steel is about a 50-50 proposition—50% pig iron and 50% scrap. Today, because of the tremendous demand for steel, it's a 50-50 proposition in another sense, too. For the more scrap you can start on its way to the mills right now, the more steel the mills can supply you with next year.

How much scrap can you dig up? Not just the obvious scrap on the plant junk pile, but the hidden scrap in unused or abandoned equipment of every kind. Even with all your other duties, here's a job well worth your personal attention.

Appoint a Salvage Manager. Tell him to start with a check of every article of plant equipment against this single test—*does it actually help in winning the war?* If it doesn't—it's JUNK!

And if it is junk, the Salvage Manager must have *complete authority* to order it out and on its way to the junk dealer, regardless of who in your organization may wail. At the same time, your Salvage Manager should get in touch with the Chairman of your local Salvage Committee and cooperate with him in every way possible. For here again, it's a 50-50 proposition, and the more scrap can be turned out from every source, the more you and the nation will benefit.

A printer in Coatesville—and that's a city of less than 15,000—turned in 12,850 pounds of scrap in the form of an obsolete printing press . . . and that's enough to build half a medium tank. Perhaps you've got the makings of the other half.

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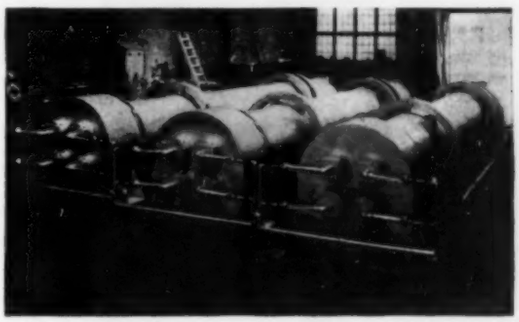
Lukens Clad Steels — Nickel-Clad, Inconel-Clad and Monel-Clad — consist of a light layer of the corrosion resistant metal bonded to a heavier plate of steel. Since the clad surface has the same corrosion resistant qualities as solid nickel, Inconel or Monel, Lukens Clad Steels have proved over a number of years their entire adequacy in combating many types of corrosive action, and in preventing harmful metallic contamination in a wide variety of equipment.

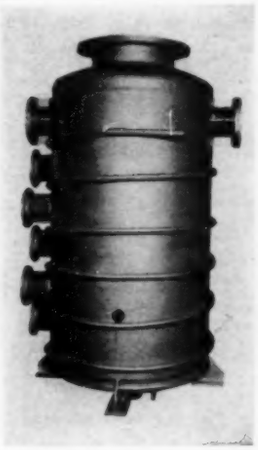
Lukens Clad Steels, used in place of the corrosion resisting metal in solid form, result in a substantial saving in cost, *and a most important conservation of these vital metals.*

Combats CAUSTIC — Used in the production of iron-free caustic soda, these three evaporator bodies are each 7′ 6″ in diameter, with a 14′ 0″ cylindrical section and cone bottom of 5/16″ thick Lukens Nickel-Clad Steel; the upper heads are of ⅜″ thick Lukens Nickel-Clad Steel. Equipment designed and fabricated by Zaremba Company, Buffalo, N. Y.



Combats SALT — These rotary salt driers, 30′ 0″ long and 3′ 6″ I.D., are made of 20% Lukens Nickel-Clad Steel which protects them from corrosive action of wet salt and brines, and prevents harmful metallic contamination of the product. Equipment fabricated by Struthers-Wells, Warren and Titusville, Pa.

Combats SULFURIC ACID — Used in oil sulfonation, this chemical mixing digester, 4′ 0″ in diameter and 6′ 6″ long, is built of ¼″ thick, 20% Lukens Monel-Clad Steel. Monel is superior to nickel in its resistance to sulfuric acid corrosion. Equipment fabricated by R. D. Cole Manufacturing Co., Newnan, Ga.



Combats COMPLEX ORGANIC REACTIONS — This chemical reaction vessel, 3′ 0″ in diameter and 5′ 0″ high, handles complex organic chemical reactions. To resist corrosion and maintain product purity, it is built of Lukens Inconel-Clad Steel, including the weir box. Accessories are solid Inconel. Equipment fabricated by Liberty Coppersmithing Company, Philadelphia, Pa.

This bulletin gives tables of recommended applications of Lukens Clad Steel equipment according to industry and chief corrosive agent. Over 125 illustrations. Ask for it on company letterhead, and also receive our illustrated magazine "Clad News," describing Lukens Clad Steel installations in many industries.

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TARRIFF COMMISSION REPORT ON SYNTHETIC ORGANIC CHEMICALS

(Production and sales in thousands of pounds; sales value in thousands of dollars)

Coal-tar chemicals	1935–39 average	1940	1941	Increase 1941 over 1940, percent
Intermediates:				
Production	506,275	805,807	1,006,564	24.9
Sales	219,366	315,967	430,495	36.2
Sales value	31,620	46,428	63,845	37.5
Finished coal-tar products:				
Production	339,279	522,851	764,424	46.2
Sales	286,469	402,325	638,172	58.6
Sales value	119,764	171,682	285,000	66.0
Dyes:				
Production	109,130	127,834	168,595	31.9
Sales	107,174	122,677	176,791	44.1
Sales value	60,621	76,432	113,308	48.2
Medicinals:				
Production	12,628	18,214	29,775	63.5
Sales	10,567	15,010	24,856	65.6
Flavors and perfume materials:				
Production	4,277	5,485	9,931	81.1
Sales	4,005	5,062	8,893	75.7
Coal-tar resins:				
Production	127,300	222,943	334,200	49.9
Sales	94,904	153,521	255,721	66.6
Sales value	17,851	33,378	66,620	99.6
Non-coal-tar chemicals:				
Production	2,321,422	3,933,083	5,009,953	27.4
Sales	1,129,760	1,989,284	2,706,195	36.0
Sales value	131,544	265,307	375,722	41.6

Production and sales of Specified Synthetic Coal-Tar Chemicals

	Production lb.	Sales lb.	Sales Value
Acetanilide	561,025	722,074	$188,310
Acetophenetidin	1,490,602	1,435,471	1,176,084
Acetylsalicylic acid	8,084,003	7,963,233	3,539,990
Benzyl acetate	467,499	466,207	240,210
Benzyl alcohol	349,061	235,083	140,328
Butyraldehyde aniline	506,076	296,545	200,894
Coumarin	301,156	338,304	797,531
Cyclohexanol	.....	438,524	101,768
Diphenylguanidine	2,135,092	1,708,628	563,622
Diphenyl-p-phenylenediamine	1,618,294	979,005	741,191
Gallic acid, tech	342,419	.....	.....
Hydroquinol	1,883,611	1,500,020	1,264,003
Insecticides	1,145,472	.....	.....
Methyl cyclohexanol	997,645	932,026	214,599
Methyl p-aminophenol sulphate	542,885	384,695	827,062
Methyl salicylate	2,577,601	2,786,931	836,072
Phenobarbital	247,014	231,737	868,481
Phenylethyl alcohol	292,884	241,877	474,393
Phenolsulphonates	565,938	565,642	145,069
Pyrogallic acid	106,779	106,476	174,076
Salicylic acid	5,326,080	3,735,227	962,641
Sodium salicylate	964,429	1,013,934	465,253
Textile chemicals	17,718,859	18,058,263	4,859,667
Thiocarbanilide	349,055	.....	.....
Vanillin	686,360	490,332	1,574,153

Production and Sales of Specified Synthetic Non-Coal-Tar Chemicals

Acetaldehyde	179,516,009	.....	.....
Acetic acid, 100 percent	225,671,063	.....	.....
Amines	3,190,659	2,711,790	1,405,820
Amyl acetate, normal, 90 percent	3,139,328	3,539,737	404,190
Barbituric acid and derivatives	297,510	240,219	1,114,700
Butyl acetate	100,381,337	99,911,717	9,149,098
Citronellal	563,996	128,941	266,081
Ethyl acetate, 85 percent	94,689,878	84,417,562	5,596,181
Ethyl ether	22,645,521	21,029,160	2,716,202
Ethyl malonate	249,725	.....	.....
Ethyl oxalate	683,423	.....	.....
Geraniol	452,154	474,927	774,942
Glyceryl monostearate	404,673	364,020	111,613
Lacticacid, edible, 100 percent	1,210,491	1,189,486	249,309
Methyl acetate	1,077,391	.....	.....
Methyl chloride	3,845,316	3,916,152	450,830
Oxalic acid	15,851,200	14,969,690	1,549,067
Plasticizers	12,118,032	10,274,328	3,966,596
Sulphated fatty alcohols, acids	24,122,528	22,829,466	6,055,545
Terpineol	962,213	957,056	268,646

Production and Sales of Certain Synthetic Resins

	Production lb.	Sales lb.	Sales Value
Coal-tar, total	334,200,666	255,721,097	$66,619,834
Alkyd resins:			
Phthalic anhydride	128,362,566	63,672,053	12,475,807
Derived from tar acids:			
Cresols or cresylic acid	22,717,921	17,312,666	6,259,363
Phenol:			
For casting	6,661,760	7,018,797	3,436,711
For molding	41,333,155	40,941,741	12,978,878
For other uses	50,645,064	49,484,635	9,209,865
Phenols and cresols	34,959,533	34,974,799	17,331,685
Xylenols	309,662	321,780	57,726
All other	49,211,005	42,294,626	4,869,799
Non-coal-tar, total	103,599,021	92,586,373	50,636,117
Maleic anhydride	9,473,995	8,357,314	1,117,625
Urea	34,848,718	33,370,720	10,797,582
All other	59,276,308	50,858,339	38,720,910

PERSONALITIES

Underwood & Underwood
A. A. Anable

Frederick W. Sullivan, Jr.

✦ A. A. ANABLE of the Dorr Co., New York, N. Y., is on leave of absence. He has been commissioned lieutenant commander in the United States Naval Reserve and assigned to active duty in an administrative capacity at the Midshipman School in New York. Commander Anable served as an ensign in the Navy Reserve in 1917-19 aboard one of the navy transports that carried the first A.E.F. to France. He had become associated with the Dorr Co. shortly after World War I and has been with the company continuously since that time.

✦ J. MITCHELL FAIN has been granted a leave of absence for the duration from his duties as chemical engineer at Foster D. Snell, Inc., Brooklyn, N. Y. Major Fain has been called to active duty in the Chemical Warfare Service and is now stationed at the Chemical Warfare School, Edgewood Arsenal, Maryland. Prior to being called on active duty Major Fain was engaged in chemical engineering work connected with the processing of strategic metals.

✦ HERBERT TERRY, a bachelor of science graduate of the College of the City of New York, has joined the staff of Foster D. Snell, Inc., Brooklyn, N. Y. Other recent additions to the staff are: Norman Fine, a graduate of Cooper Union, Alvin Gruder of Long Island University, and Anne Sullivan of Adelphi College.

✦ WALLACE T. MONTAGUE has been elected a vice president of Norton Co., Worcester, Mass., by the board of directors to fill one of two existing vacancies. Mr. Montague has charge of sales planning and development, and has held the title of assistant vice president. An alumnus of Worcester Polytechnic Institute of which he is now a trustee, Mr. Montague entered the Norton Co. organization in 1912 and has devoted his talents chiefly to research and sales.

✦ FREDERICK W. SULLIVAN, JR. has been appointed technical director of the Institute of Gas Technology, Chicago. The appointment became effective September 1. Dr. Sullivan came to the Gas Institute from the Barrett Division of Allied Chemical & Dye Corp. in which he had been manager of chemical research since 1940. Previous to that service he was director of research for the Standard Oil Co. of Indiana. He had joined that organization as assistant director of research in 1923, and left there in 1938. He received his Bachelor of Science, Master of Science and Ph.D. degrees in 1918, 1919 and 1921, respectively, from the University of Michigan. During the first World War, he served as a lieutenant in the Sanitary Corps after training at Rockefeller Institute.

✦ FRANCIS BOYER has been elected a director of the Pennsylvania Salt Mfg. Co. to fill the vacancy resulting from the death of Samuel D. Warriner on April 3. Mr. Boyer is executive vice president and director of the Smith, Kline & French Laboratories of Philadelphia.

✦ W. J. REAGAN has been appointed as melt shop research metallurgist with the Copperweld Steel Co., Warren, Ohio. Mr. Reagan was previously connected with the Edgewater Steel Co.

✦ S. A. MONTGOMERY has been appointed manager of the Whiting, Ind., refinery of Standard Oil Co. of Indiana. Mr. Montgomery, formerly manager of the Wood River, Ill., refinery of the company, succeeded Dr. E. J. Shaeffer, who has been in ill health and has retired from active service. The general superintendent of the Wood River refinery, Dr. W. J. McGill, has been promoted to succeed Mr. Montgomery as manager at Wood River and T. E. Stockdale, an assistant superintendent of heavy oils department in Whiting, has been promoted to succeed Mr. McGill as general superintendent at Wood River. Mr. Montgomery joined the company in 1919 as a chemist at the Wood River refinery after his discharge from the Chemical Warfare Service at the end of World War I. Before enlisting in the service, he had gained a Bachelor of Science degree in chemistry at Mississippi State College. At Wood River he had been successively assistant superintendent of the paraffine department, superintendent of the lubricating and paraffine department, assistant general superintendent, and general superintendent of the refinery, before being promoted to manager in 1934. Dr. Shaeffer joined Standard in 1915 as a chemist at Whiting after receiving a Ph.B. at Brown University and a Ph.D. at Johns Hopkins. Dr. McGill became associated with the company in 1924 as a chemist at Whiting after receiving his Ph.D. degree from the University of Michigan. Mr. Stockdale is a graduate of the University of Illinois and joined Standard in 1923 as a designer and a draftsman at Whiting.

✦ JOHN MUNRO has been promoted to the position of vice president in charge of a new procurement division of the Whiting Corp., Harvey, Ill. This new division will cover purchasing, expediting and priorities.

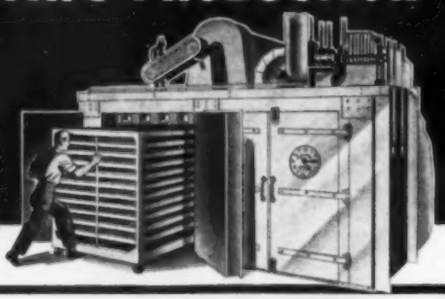
✦ ROBERT S. ARIES has been named research engineer on the technical staff of the Connecticut Hard Rubber Co., New Haven, Conn. He will devote his effort to development of synthetic resins and plastics. Mr. Aries was formerly doing research work on the project of the Northwood Chemical Co. of Phelps, Wis., at the Polytechnic Institute of Brooklyn in the field of wood chemistry.

✦ HAROLD R. ALLEY is now associated with Tested Papers of America, Inc., as technical director. The organization maintains a sales office and a modern paper testing laboratory in the Carbide & Carbon Building, Michigan Blvd., Chicago. Mr. Alley was formerly associated with the testing department of Commonwealth Edison Co. of Chicago.

✦ CHESTER W. SMITH has joined the staff of the Detroit Rex Products Co., Detroit, Mich., as research chemist in the alkali division. Mr. Smith has been a specialist in the field of electrochemistry as applied to electroplating for the past eight years. He was formerly affiliated with the J. C. Miller Co. as chief chemist, working on research and development of materials for the field of electroplating.

✦ WILLIAM E. VOGT has been elected secretary of Electro Metallurgical Sales Corp., a unit of Union Carbide & Carbon Corp. His headquarters will continue to be in New York. Mr. Vogt who

SPEED UP CHEMICAL DRYING PRODUCTION with DESPATCH



★ ★ ★

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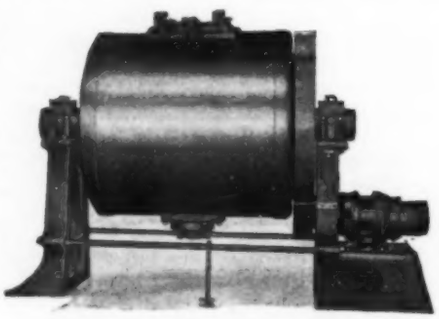
are being used in every field of industry where low labor efficiency requirements and immunity from break downs are important.



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are now processing materials for smokeless powder, tracer powder, black-out and camouflage paints, abrasives, welding wire coverings, porcelains, drugs, chemicals, nitro-cellulose, and many other products and substances.

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is a native of New York, has been connected with units of Union Carbide for more than 30 years.

✦ OLIVER BOWLES, for many years a member of the staff of the U. S. Bureau of Mines, has been named chief of the Nonmetal Economics Division of the Bureau. In this position he succeeds Paul M. Tyler, who has resigned from the Bureau to serve on the staff of the Board of Economic Warfare with respect to nonmetallic minerals.

✦ HARVEY P. LYNN, JR., is now a lieutenant in the Chemical Warfare Service. At present he is stationed in Texas.

Victor E. Williams

✦ VICTOR E. WILLIAMS, assistant general manager of sales of the Organic Chemicals Division of Monsanto Chemical Co., with headquarters in New York, has been promoted to the position of director of sales of the division. He will remain at his present location in New York. Promotion of Frederick C. Renner, assistant general manager of sales of the Organic Chemicals Division, to general manager of sales with offices in St. Louis, also has been announced. Mr. Williams was born in 1895 in St. Louis. Following his schooling in the St. Louis public schools he started work in 1915 as office boy to John F. Queeny, founder and first president of Monsanto. After serving with the Missouri National Guard on the Mexican border in 1916, he returned to the company and in 1918 his National Guard unit was mobilized and Mr. Williams was sent overseas. He returned in 1919 and was assigned to the export sales department later being promoted to supervisor of the order and billing department. In December 1938, he was promoted to assistant general manager of sales of the Organic Chemicals Division.

✦ RICHARD K. TONER on September 1 joined the faculty of Princeton University as an assistant professor of chemical engineering. Heretofore he has been connected with the department of chemical engineering at New York University.

✦ J. K. MISSIMER has joined the staff of the paper section of the National Bureau of Standards as papermaker. He, together with M. J. O'Leary, who has served for a number of years as papermaker, will operate the semi-commercial papermaking equipment of the Bureau. Mr. Missimer is well qualified for the position as during his former connection with the Standard Paper Manufacturing Co., Richmond, Va., he had considerable experience in their semi-commercial experimental paper mill, as well as in their commercial mill.

✦ RICHARD H. GRIMM, of New York City, has been appointed chief of the industrial alcohol unit by the Chemicals Branch, W.P.B. Mr. Grimm started his business career with the American Distilling Co. at Pekin, Ill., and became its president in 1923. In 1928, the company was merged with others into the American Commercial Alcohol Corp. and Mr. Grimm became president of the combined concerns. He retired from this and other allied companies in 1933 and has been in retirement since except for a term as president of the Industrial Alcohol Institute in 1935.

✦ CHARLES D. LUKE, head of the department of chemical engineering in the College of Applied Science, Syracuse University, has been given leave of absence to begin active duty with the army. Before coming to Syracuse, Dr. Luke was associated with Standard Oil Co. in Louisiana, and the de Florez Engineering Co. He was appointed to the Syracuse faculty in 1937, became acting head of the department of chemical engineering in 1939, succeeding the late Dr. Lloyd Logan. He was later appointed to the chairmanship of the department.

✦ H. W. ANDERSON has been promoted to the vice presidency of the Aviation Division, Whiting Corp., Harvey, Ill., and M. J. Rice has been made vice president of the Quickwork-Whiting Division of the company.

✦ WRIGHT W. GARY has resigned as director of refining for the Office of Petroleum Coordinator for War. Mr. Gary leaves his government post to become president of a West Coast corporation manufacturing aviation gasoline.

✦ JACK M. HOY has left Foote Mineral Co., Philadelphia, Pa., to accept a position as chemical engineer in the production department of Climax Molybdenum Co., Langeloth, Pa.

✦ H. V. FAIRBANKS has been appointed assistant professor of chemical engineering at Rose Polytechnic Institute, Terre Haute, Ind. He began his work on September 1.

✦ JOHN N. COSBY, formerly with the Research Foundation, Penn State Uni-

6 WAYS* TO DO A BIGGER WAR JOB WITH STAINLESS STEEL EQUIPMENT

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#6 COLLABORATE WITH YOUR FABRICATOR...

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Higher Chemical Purity
in
"U. S." RASCHIG RINGS
White Porcelain or Chemical Stoneware

"U. S." white porcelain or chemical stoneware raschig rings are outstanding in the fundamental qualities required of a good raschig ring: *mechanical strength, chemical purity, and uniformity.*

Vitrified at temperatures of 2500 deg. F., "U.S." raschig rings cannot soften or crumble. Their extremely low co-efficient of thermal expansion prevents chipping, cracking, or spalling under rapid heating or cooling.

Our non-absorbent, zero-porosity, iron-free, white porcelain bodies permit easy and thorough flush cleaning, eliminating the danger of contamination or discoloration of following solutions.

They are unreservedly guaranteed, as is chemical stoneware, to be inert to the action of all acids, solvents, and corrosive solutions, with the exception of hydrofluoric acid and hot alkalies.

Write for Bulletin No. 54 on Modern Tower Packing

As a manufacturer of corrosion-resistant equipment from natural rubber, synthetics, alloys and ceramics, we would like to point out that "U.S." Standard Chemical Stoneware is made 100% from non-critical materials, and is one material of construction for which priorities are not necessarily a pre-requisite to obtain.

The substitution of "U.S." Standard Chemical Stoneware for synthetic, metal and rubber process equipment means more planes . . . more tanks . . . more guns . . . and a quicker victory.

Our engineers will be glad to explain the many ways in which versatile chemical stoneware can release strategic materials for the more vital needs of war.

U. S. Stoneware
AKRON • OHIO

ENGINEERS, MANUFACTURERS, ERECTORS of CORROSION RESISTANT EQUIPMENT

versity, has joined the research organization of the General Aniline & Film Corp., New York. Among the other recent additions to the staff are: Dr. William O. Ney, Jr., University of Texas; Dr. Charles W. Stein, University of Pennsylvania; Dr. Marvin O. Shrader, Yale University; Dr. John C. Lawler, University of Illinois; Dr. J. P. G. Beiswanger, Northwestern University; Dr. L. M. Schenck, University of Texas; and Dr. Ben H. Kirby, University of Iowa.

✦ RALPH E. DAVIS, JR. has joined the sales department of the Hooker Electrochemical Co., Niagara Falls, N. Y. Mr. Davis has been superintendent of the tannery of Maylander Bros., glove and garment leather manufacturers of Johnstown, N. Y., for the past six years and previously was superintendent of the tannery of Martin Littell Leather Corp., Gloversville, N. Y.

John B. Karrh

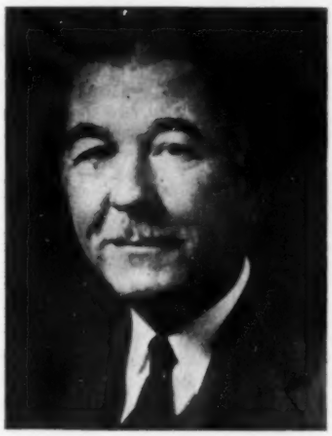
✦ JOHN H. KARRH has joined the sales division of Westvaco Chlorine Products Corp., New York. For 11 years Mr. Karrh was associated with the Victor Chemical Works, serving as New York sales manager for the past 4 years. A chemical engineering graduate of the University of Alabama, he previously was foreign technical representative of Swann Chemical Co. of Birmingham in the installation of its processes in European chemical plants.

✦ K. C. FRAZIER has been appointed district sales manager of the New York Metropolitan area for Columbia Chemical Division, Pittsburgh Plate Glass Co. Mr. Frazier is a graduate of Colgate University and for the last ten years has been Southwestern manager of Southern Alkali Corp. an affiliate of Pittsburgh Plate Glass.

✦ F. C. TODD, formerly a member of the faculty of Pennsylvania State College has joined the technical staff of Battelle Memorial Institute of Technology, Columbus, Ohio. He has been assigned to research and industrial physics. Another new member of the technical staff of Battelle is Robert L. Warfel who has been named a research engineer and

has been assigned to the division of analytical chemistry.

✦ CHARLES A. THOMPSON, of the Pittsburgh office of Robins Conveying Belt Co., Passaic, N. J., has become a lieutenant in the U. S. Navy. A graduate of Carnegie Institute of Technology, Lieutenant Thompson had considerable engineering experience before joining Robins sales staff.



W. I. Galliher

✦ W. I. GALLIHER, director of sales of the Columbia Chemical Division of the Pittsburgh Plate Glass Co., will be in charge of sales activities from the new headquarters at Pittsburgh. The executive sales office of the Division has been moved to Pittsburgh from New York. The move is a continuation of the company's program of co-ordinating its various divisions in the general office at Pittsburgh.

✦ AMORY HOUGHTON, who has served for some time as director general for operations in the War Production Board, has resigned. He returns to the Corning Glass Works of which he is president. Mr. Houghton became director general for operations under the realignment announced in July. He has served with the Government since December of 1941. His first post was as assistant deputy director of the Materials Division of the former Office of Production Management. Since early 1942, however, he has been deputy chief of the Bureau of Industrial Branches, before coming to director general.

✦ C. L. CLARK of Westinghouse Electric & Manufacturing Co. for the past 13 years has been attached to the Cleveland office of the Wheelco Instruments Co., Chicago, as sales engineer. Robert N. Miller, for the past seven years sales and service engineer for Mercoid Corp., is now service engineer with Wheelco.

✦ THOMAS MATCHETT, president of Robins Conveying Belt Co., Passaic, N. J., has been appointed to the Conveyor and Mechanical Power Transmission Industry Advisory Committee of WPB.

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TODAY, more than ever, it will pay you to investigate what Beckman pH Control can do in solving YOUR corrosion problems. For, with Beckman-controlled processing operations, corrosion can often be licked without need for costly and hard-to-get corrosion-resisting materials . . . because Beckman pH Control takes the "corrosion" *out* of process solutions *before* they contact valuable plant equipment. *For example . . .*

IN COOLING SYSTEMS, the water, through absorption of atmospheric CO_2 in the cooling towers (forming carbonic acid), tends to become increasingly acidic as it is recirculated, leading to excessive corrosion of machines, condensers, and other plant equipment. In addition, in many plants chemicals used in process solutions may leak into the cooling water through condenser leaks or breaks, causing damaging corrosion of plant equipment.

SOLUTION: Many plants now guard against these costly dangers by installing Beckman pH Control on the cooling water circuit. Leaks into cooling system are instantly detected—cooling water is *automatically* maintained at optimum pH for minimum corrosion!

IN PAPER PLANTS, the whitewater treatment leaves the pulp highly acid. This acid pulp, feeding into the wet end of the machine, corrodes the costly wire screens and paper machinery. Result—short screen life, high upkeep, expensive maintenance.

SOLUTION: In many paper mills this problem is being solved by Beckman-controlling the whitewater treatment to neutralize excess acidity *automatically* before the pulp enters the machine. By thus maintaining a pH controlled pulp, corrosion is not only minimized, but the properties of the finished paper are greatly improved . . . *a two-way saving!*

LET US HELP *YOU!* Chances are *you* can reduce corrosion—*and at the same time increase plant efficiency*—through the intelligent application of Beckman pH Control. Let our engineering department make recommendations to fit *your* particular problem.

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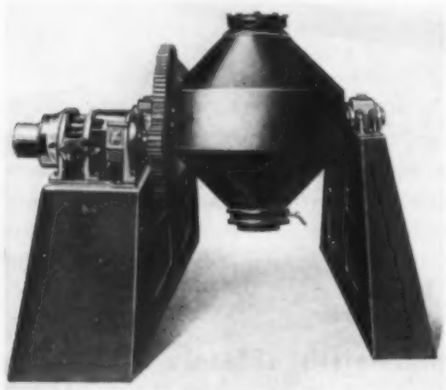

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Double Conical Dry Blender for active dispersion and blending chemicals, plastics, minerals, etc. Built of any metal, employing any drive, capacities—1 to 250 cu. ft.

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FLETCHER HIGH SPEED CENTRIFUGALS

WITH EXCLUSIVE FLETCHER SAFETY FEATURES!

✦ FRANK M. STEPHENS, JR., has been named a research engineer on the technical staff of Battelle Memorial Institute, Columbus, Ohio. He has been assigned to the materials beneficiation division. Mr. Stephens is a graduate of the Colorado School of Mines.

✦ LUCIUS W. ELDER has been appointed director of the physical chemistry section of the Central Research Laboratories of General Foods Corp. Dr. Elder has been engaged in research work with General Foods since 1932, when he joined the staff of the Post Products Division's laboratories at Battle Creek. He was transferred to Hoboken, N. J., in 1939 when the Central Laboratories were organized.

OBITUARIES

✦ EDWIN L. SMALLEY, president of the Hevi Duty Electric Co., died in Milwaukee August 29 at the age of 65. As a pioneer in the electric heat treating furnace industry, he was the holder of a considerable number of furnace patents.

✦ ARTHUR H. THOMAS, president of the company which bears his name, died at his home at Haverford, Pa., August 30. He had been ill three months, and was 69 years old.

Born in Beaver County, Pa., Mr. Thomas attended the Westtown Boarding School, and in 1892 entered the employ of the old Philadelphia firm of James W. Queen, manufacturers of optical instruments. He founded his own company in 1900.

At his death he was a trustee and director of Bryn Mawr College, and member of the board of managers of Haverford College. He was also a member of the board of the Prudential Mutual Life Insurance Co.

✦ HAROLD CLARK, assistant treasurer, assistant secretary, and personal director of The International Nickel Co., Inc., died suddenly on the morning of August 25 at his home in Westfield, N. J. Mr. Clark had been associated with the metal industry for many years, starting in 1919 as registrar to the Mond Nickel Co., Ltd., London, England.

✦ FRANCIS J. AREND, founder and president of De Laval Steam Turbine Co., died August 24 at the Fitkin Memorial Hospital, Neptune, N. J. He was also president of De Laval Separator Co.

✦ FREDERICK LEE STONE, vice president and director of Universal Atlas Cement Co., a United States Steel subsidiary, died at St. Mary's Hospital, Rochester, Minn., on August 17, following an operation. Mr. Stone was 66 years old. He was born in Camden, Ark., in March, 1876, studied at the University of the South, Sewanee, Tenn., and at the United States Naval Academy.

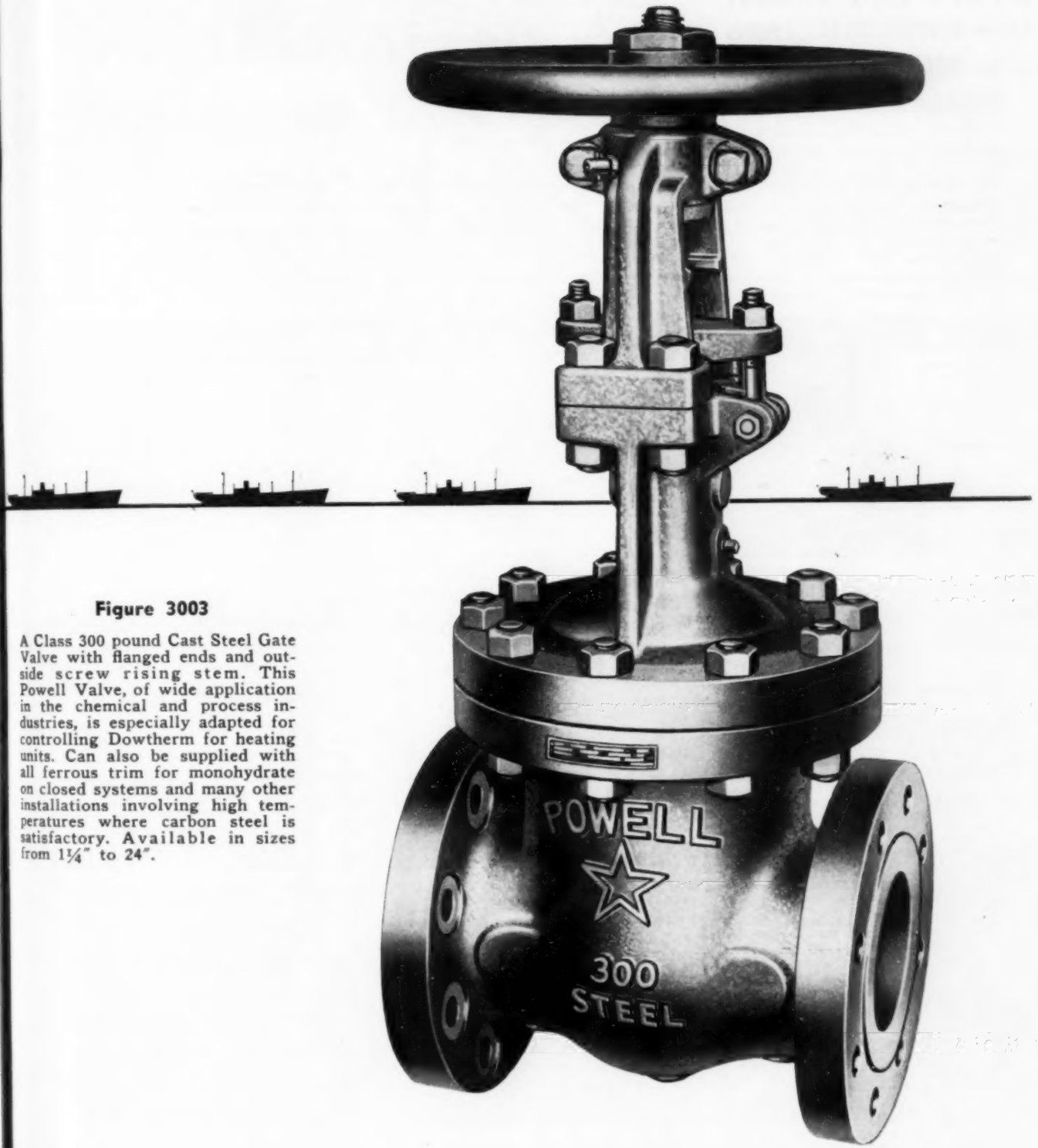

Figure 3003

A Class 300 pound Cast Steel Gate Valve with flanged ends and outside screw rising stem. This Powell Valve, of wide application in the chemical and process industries, is especially adapted for controlling Dowtherm for heating units. Can also be supplied with all ferrous trim for monohydrate on closed systems and many other installations involving high temperatures where carbon steel is satisfactory. Available in sizes from 1¼" to 24".

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Type G-1-1, commercial size. Oper. pres. ⅜"—300 lbs.; 1½"—110 lbs.; higher pressures and larger I.P.S. sizes in G-3 and G-4 Series.

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READERS' VIEWS AND COMMENTS

Readers are invited to express their views on articles appearing in Chem. & Met. *or on other subjects of interest to chemical engineers. As far as our space permits such views and comments will be published in these columns. Address your letter to the Editor of* Chem. & Met., *330 West 42 St., New York, N. Y.*

MORE ON "INDUSTRIAL AMERICANIZATION"

To the Editor of Chem. & Met.:

Sir:—In your editorial on "Industrial Americanization," appearing in the April issue (Page 74), you discussed the seizure of the formerly I.G.-operated General Aniline & Film Corporation by the United States Treasury and the placing of the corporation under the control of the Alien Property Custodian. You also commented on the appointment of a board of directors to reorganize and operate the corporation as an American concern.

It may therefore be of interest to your readers at this stage to know something of the scientific problems which confront those charged with this duty of reorganization. That is the purpose of this letter.

Under the former management, as now appears, while the factories of the Corporation were efficiently staffed and operated, research and development activities in their broader aspects were retained in Germany under the control of the I.G. It becomes, therefore, one of the major tasks of the new management to create as quickly as conditions allow, an integrated research organization adequate to the immediate and future needs of the Corporation as an American enterprise. This is vital not only to insure maximum contribution by the Corporation to the war effort but to prepare foundations for continuing development after the war.

The General Aniline & Film Corporation controls, among other assets, a considerable number of U. S. patents granted to the I.G., the contents and value of which are at present largely untested. These in themselves represent a portfolio of great potential industrial importance, as examination of only a few patents has already revealed. Many of these represent the latest products of I.G. research which have not hitherto been developed to useful ends. The scientific appraisal of these patents and the selection for early development of those which can immediately contribute to the war effort is in itself a considerable and urgent task.

It is unique in industrial history that research opportunities of such magnitude have been created by the fact of a large and efficient manufacturing organization being suddenly deprived of the scientific foundations necessary to its healthy progress and to its powers of new creation.

To rectify this is one of the urgent tasks now confronting the Directors and Officers of the Corporation, particularly of Dr. E. C. Williams, chemical director, and of Dr. W. F. Zimmerli, vice president in charge of patents and research. It presents a challenge and an opportunity for service and accomplishment to a large number of experienced scientific workers and of those starting on their careers.

While public announcements regarding the Corporation have already led to many applications being received, it is the management's wish, (in order that there may be no thought of improperly competing for men with other industries active in the war effort) that the nature and full scope of its needs be realized both by scientists and by company executives.

We hope that we can successfully establish in times of exceptional difficulty and with the wholehearted good will of other industries, the kind of research organization that is needed to perform the important tasks assigned to us. It is our purpose so to do.

ROBERT E. MCCONNELL
President
General Aniline & Film Corp.
New York, N. Y.

NEEDED: A CHEMICAL "AMICUS CURIAE"

To the Editor of Chem. & Met.

Sir:—Whether in chemistry, literature or law, sound argument of basic principles is always to be encouraged with confidence that brisk discussion and true reasoning will lead to important conclusions. Mere agitation either amiable or animated and excited usually ends in blank distraction.

The recent editorial in your magazine on "Congressional Engineering," as its title hints, offers pleasant satire on discussions in Congress during the past summer with respect to the production of alcohol, butadiene and synthetic rubber. The editorial stated a powerful truth when it said that "the rubber program has been badly mishandled from the start." Cordial approval may be offered to the remark criticizing some government agencies "whose negotiations were cloaked with unnecessary and suspicious secrecy." The writer took a pleasant thrust at our great American Legislature as he wrote "Congress stepped in and added to the confusion."

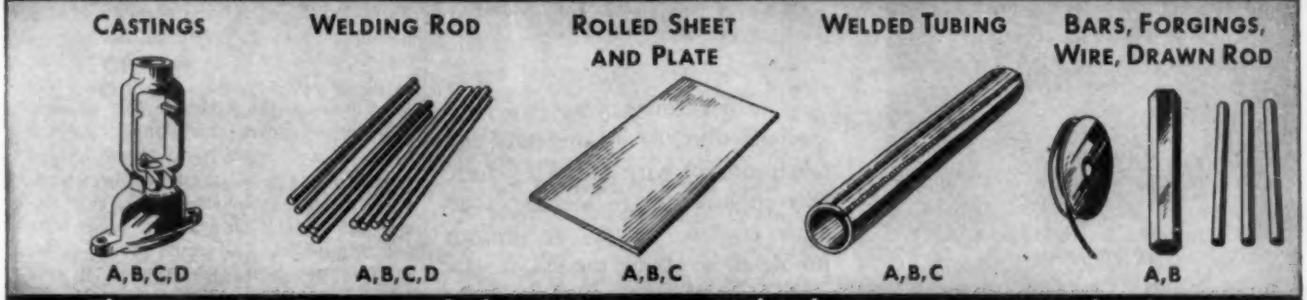
The principal function of our government in war is to destroy the enemy. Next most important is to endeavor to keep our people in condition calmly to face disaster caused by the enemy or the elements. Production of rubber, next to food, is the most important function of the government. Civil as well as military requirements must be met. The automobile has become the chief auxiliary of the American family—almost as essential as the bathroom. To be deprived of the use of the automobile means a sacrifice not lightly to be endured.

Do You Know These Facts About HASTELLOY ALLOYS...

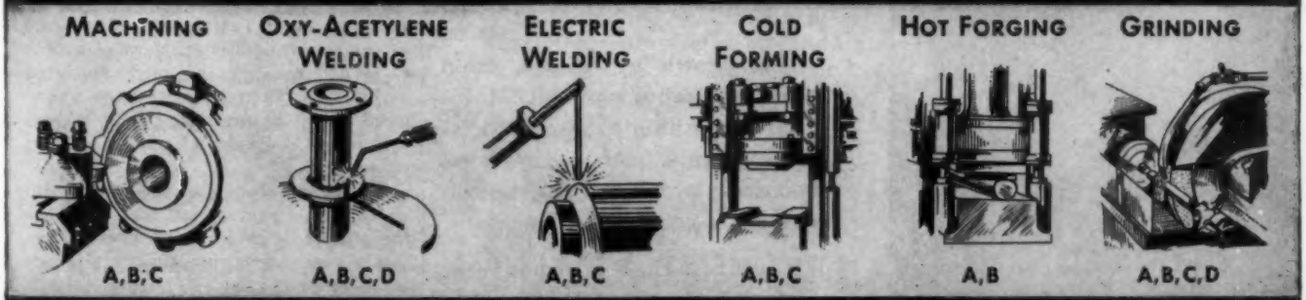
For Resistance To Severely Corrosive Media?

For resistance to severely corrosive media, use one of the four Hastelloy nickel-base alloys — A, B, C, or D. Many types of chemical equipment—such as valves, pumps, pipe and fittings, autoclave liners, heating or cooling coils, agitators, and acid concentrator tubes — are being fabricated from these high-strength alloys. Outlined here are some of their properties.

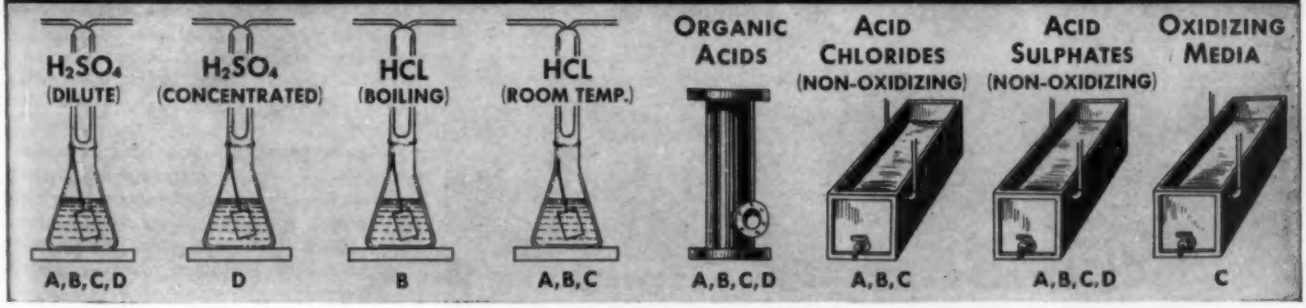
These are the Forms in Which You Can Get Them



These are Some of the Ways in Which You Can Work Them



These are Some of the Corrosive Media They Resist



For Complete Information on penetration tests, available forms, and methods of fabrication of Hastelloy alloys, send for the booklet, "Hastelloy High-Strength Alloys." Test samples of these nickel-base alloys are also available.

HASTELLOY TRADE MARK

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

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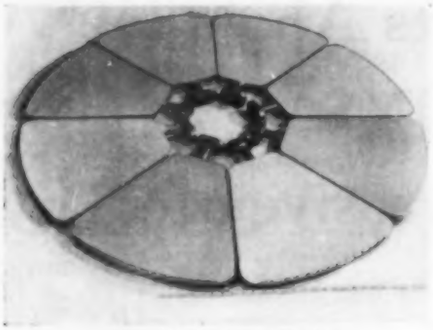
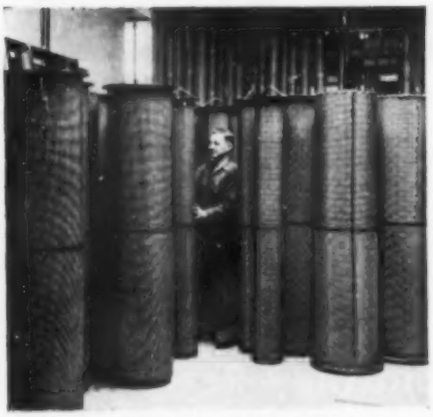
HIGH-STRENGTH NICKEL-BASE ALLOYS FOR CORROSION RESISTANCE

The word "Hastelloy" is a registered trade-mark of Haynes Stellite Company



Filter leaf of new design

Strainer units



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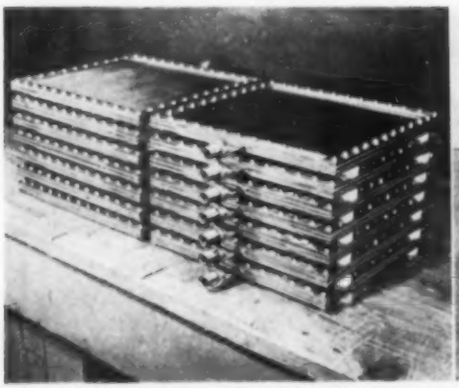
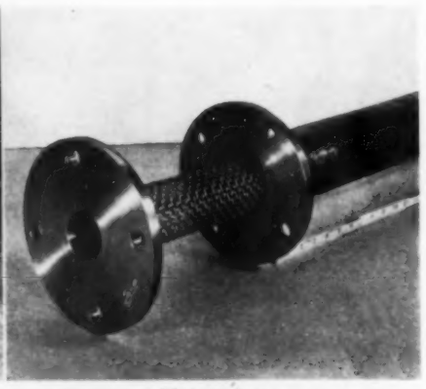
The knowledge gained from these installations now puts Multi-Metal in position to assist process plants to cope with today's vital production problems. This knowledge can save time and money.

If your particular requirement rates the necessary Priority—we have the experience, the men and the machines to do the work.



All stainless, pressure filter leaves



Line strainer

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ALL MESHES
ALL METALS

When the war cut off our supply of natural rubber, we realized our need to economize rubber until a substitute could be procured. The government acted without delay to procure this substitute by making an allocation of 650 million dollars.

Since then, patience has been perplexed by annoying rumors as to rationing of tires and intimations that all tires would be confiscated. The latter possibility was hurriedly qualified, then entirely denied with the assurance that tires would be allowed all civilians for "essential uses." The rumors had the effect of arousing the people to make impatient demands as to the prospects of getting synthetic or substitute rubber or anything answering the purpose of rubber for automobile tires. Then began the criticism of some agencies "whose negotiations were cloaked with unnecessary and suspicious secrecy." Criticism, not always gentle, grew in volume. Angry words, employed to express hazy ideas, were not turned aside with the soft answer.

During these skirmishes it was alleged that some men were charged with the production of rubber when their entire experience with this important material began and ended with the nipple of a nursing bottle. Inflammatory charges appeared in the press—usual recriminations—while scientists grieved.

Where were the leaders of chemistry at this time? Individually they were as competent and eloquent as ever. But it is not recalled that any concerted action was taken to soothe the public mind with assurances that progress was being made in a most important endeavor.

Agitation throughout the country insisted that Congress act to investigate the alleged delay in production of syn thetic rubber and incidentally find out what became of the 650 million dollars. Congress acted. A Senatorial Committee was appointed and the work of investigation began. Some supercilians thought that Congress was intruding when, as a simple fact, it was exercising its absolute right to get the truth as to expenditures of large sums of money.

Again leadership in chemistry was sought. Factional quarrels developed using the Senate Committee hearing room as a sounding board to proclaim that some interests were being preferred to the exclusion of others.

Presently a clean-cut issue was drawn as to the wisdom of getting what we wanted—rubber—from petroleum or from the farmers' grain. This was the time for the chemical press of the country to have advanced with the slogan, "Let's get rubber from petroleum, grain or coal—what matters the source as long as we get the product."

Unhappily the agitation which stirred the public mind became acute as o the merits of the oil well or the grain field. Since the farmers have public sympathy at all times, Congress passed on July 24 by a large majority a bill (S. 2600) to be cited as the "Rubber

Supply Act of 1942." On August sixth the President vetoed this rubber bill. His veto message is still lying on the desk of the Secretary of the Senate awaiting the appearance of a quorum of that body.

In making its report to the Senate, the Committee delivered itself of the following opinion, ". . . the dollar-a-year men in the Chemicals Branch of the War Production Board were fearful that the war might end suddenly and that there might be some surplus of industrial alcohol that would provide competition for companies with which many of these officials have been associated for a long period of time." Whether or not any of these dollar-a-year men were chemists or chemical engineers has never been shown, but the opportunity invited leaders in these fields to cure the public mind of wrong impressions that might follow the recorded opinion of the Senate Committee.

Our law courts frequently have recourse to the "amicus curiae," friend of the court, to adjust misunderstandings. Chemistry and chemical engineering would do well to provide such a group ready and willing to act as a disinterested body when the President's message comes before the Senate for debate and action.

Likewise, it may perform a valuable duty when the report of Baruch, Compton and Conant is given to the public by the President. As part of his veto message on the Rubber bill, the President announced the appointment of these three men to a committee "to investigate the whole situation and to recommend such action as will produce the rubber necessary for our total war effort, including essential civilian use."

This trio of highly trained men may be relied upon to bring in a report, without needless delay, commanding the respect of laymen and scientists alike. No partisanship as to process or material will appear in that report. No preference as to locality or form of structure will it contain. There will be but one thought—that of getting rubber in greatest volume by quickest method.

Debate on the report is to be expected. Indeed, such debate should be given every encouragement, but it must not be allowed to grow delirious. Here is the opportunity for leadership in chemistry. The chemist's "amicus curiae" should stand ready to explain every feature of the report to all who may be dissatisfied or quibbling with suspicion.

Chemistry cannot permit the rubber situation thrust upon America by our enemy to create factional quarrels leading to permanent enmity among great numbers of our people. Chemistry should, by its own action, demonstrate the value of catalysis in leading public opinion.

JOSEPH A. CONRY
Former member of Congress
Cosmos Club
Washington, D. C.

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A Great Variety of Process Apparatus Parts

Here is the place to have your special units made to precise specifications by competent workers in a shop finely equipped for a wide range of work even in quantity production.

It is a medium size plant—not too small to lack proper equipment, or too big to overlook your individual exacting requirements—but just right for careful attention to details and strict supervision by men thoroughly familiar with processing conditions.

We are prepared to do sheet metal & light metal work requiring

Cutting	**Punching**	**Bending**
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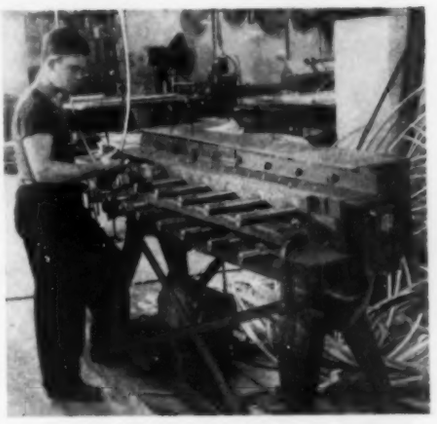
Send us your specifications. You will get an intelligent answer, promptly.

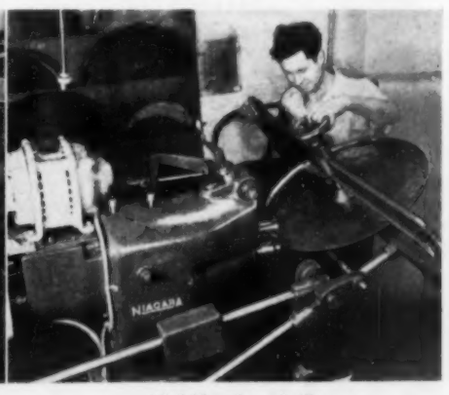
Nibbling plate for strainer bottoms

Welding pipe line strainers



Forming channel hoops

Flanging pans



Finishing bound disc

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ACE Hard Rubber helps safeguard America on land...on sea ...in the air

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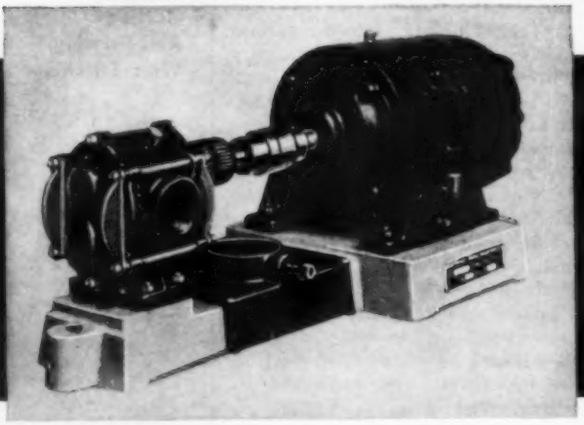
Rugged, precision parts of Ace hard rubber—all with these advantages: Acid and Alkali Resistant . . . Dependable . . . Economical . . . Non-Hygroscopic . . . Adaptable for integrally molded metal parts...Easily machined, turned and finished.



Ace hard rubber Rotary Gear Pump, Type G. Applicable to a range of uses from laboratory work to factory pumping problems. Capacity 9 gallons per minute. Also Ace hard rubber Centrifugal, Single Acting and Double Acting pumps.

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★ In the Chemical Process Industries ACE rubber lining is a strategic and indispensable material for tanks, pumps, pipe, valves, pipe fittings, tank cars, etc. ★ Engineers responsible for safeguarding equipment against corrosion know that ACE rubber lining

- . . . gives complete, positive protection against corrosion and contamination
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- . . . has a non-porous surface, smooth, easy to clean

Synthetic rubber linings, including Thiokol, Neoprene, etc., are also available

SARAN* Pipe and Fittings, iron pipe size; Injection Moldings; thin wall Tubing and Fittings.

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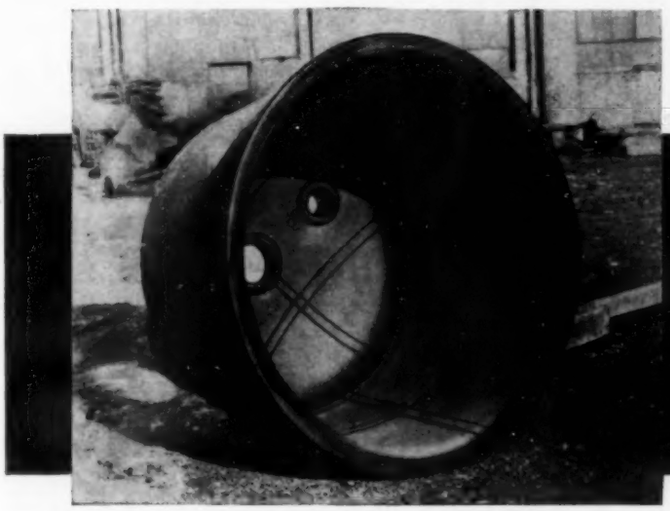


Neoprene lined Evaporator Head

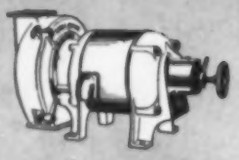
Ace rubber lined chlorine gas cooler, equipped top and bottom with Ace rubber covered tube sheets. Sheets have 673, 13/16 inch diameter holes accurately reamed.

RUBBER PROTECTION
for Defense against Corrosion

(*Trademark of The Dow Chemical Company)

UNIQUE

GRINDING



MIXING

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Tell our engineers your war production problem. Catalogs and counsel at your service!

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MANUFACTURING COMPANY

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NEWS OF PRODUCTS AND MATERIALS

PAPER BASE PLASTIC

Manufacture has been started by the Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis., of an improved paper base plastic equalling aluminum in tensile strength on a weight basis. Perfection of the process was announced recently by Carlisle P. Winslow, director of the U. S. Forest Products Laboratory at Madison, Wis., which collaborated with Consolidated in the project. This new plastic has twice the strength of any other so far produced. It can be molded into desired shapes at temperatures and pressures and on equipment now used for making plywood. It is resistant to moisture and remains extremely stable at both high and low temperatures. It is more resistant to scratching and denting than aluminum and has a smooth surface eliminating necessity for special finishes and coatings. An added advantage is that the plastic will not be corroded by salt water and if pierced by bullets will not splinter, tear or flower out.

PROTECTIVE CREAM

Industrial skin disorders which account for many occupational diseases are being prevented by the use of protective creams. Application of the cream is compulsory in a number of plants because it eliminates much of the lost time due to dermatitis. A greaseless substance called Pro-Tek protective cream, a product of the du Pont Laboratories, is applied to the hands, arms and under the nails before starting work. It forms an invisible film which gives physical protection against grime and some irritating substances. At the end of the working period it can be washed off with soap and running water, carrying the grime with it. The use of the cream eliminates the necessity of using strong solvents or harsh abrasives to remove grime, paint and the grease from workers' hands. Some cleansing materials frequently cause irritation.

INSECTICIDES

The recent announcement of Thanite, an effective concentrate for use in contact with insecticides, is produced from the Southern pine. A severe shortage of pyrethrum, derris, and cube faces the country. Available shipping space for importing normal requirements of these is so drastically curtailed that authorities have forecast a dangerous threat to public health and to agriculture. Thanite not only fulfills all the functions of a toxic ingredient, providing high knockdown and killing power plus good repellancy, but it is made 100 percent from domestic raw materials. An interesting fact uncovered by entomologists during their studies is that Thanite sprays kill female flies as readily as male flies. The female fly is said to be more resistant than the male to many toxic contact agents used in fly sprays. Its better performance against female flies means a smaller number of eggs laid wher Thanite is used.

SOLUBLE RESINATE

An interesting new group of soluble resinates, valuable for their wetting, emulsifying and detergent assisting action, are offered under the name of Dresinate by Industrial Chemical Division of Hercules Powder Co., Wilmington, Del. The new chemical materials are indicated for use in cleaning compounds, metal degreasing preparations, disinfectants and many similar industrial chemical specialties needed today.

PROTECTIVE WRAPPER

In order to save valuable man-hours otherwise spent in cleaning operations, a number of plants engaged in producing metal parts are now using a tough, moisture-proof wrapping material. It is made of du Pont cellophane film laminated to a light cotton fabric, known as scrim and then impregnated with other moisture-proof materials. It can be sealed either by twisting the ends of the package by hand or by using a heat-sealing device. The cellophane adds strength and helps make the material oil- and acid-resistant. The wrapper was developed by the Dearborn Chemical Co. of Chicago and comes in several types and thicknesses. Believed to be the most efficient material yet devised for this important use, the No-Ox-Idized wrapper (so named because it retards oxidation or rust) is being used or tested for use on a great variety of articles.

FIRE EXTINGUISHING POWDER

American ingenuity meets the increasing danger of destruction by fire with a new method that is said to be faster, surer and acts with no water damage. Whippet has proved remarkably effective against all types of fire such as gasoline, benzene, naphtha, tar, grease, oil, electric, acetylene gas, chimney and forest fires. A few handfulls of Whippet thrown on any fire, puts it out instantly. It is said to be so simple to use that a child can handle it with perfect safety. No equipment is required. It is non-poisonous and contains no noxious gases. The Halco Chemical Corp., New York, is the manufacturer.

RUBBER SUBSTITUTE

New formulations of ethyl cellulose plastic designed to replace rubber have been found suitable for many uses of the now scarce material, Hercules Powder Co., Wilmington, Del., an-

"And thank you, please, to stop making these?"

THERE'S a big difference between a device that enables a bombardier practically to drive a nail at 5000 feet and a closure that protects products in drums. But there is a *similarity* that is much more important: there are people on the other side (Atlantic and Pacific) who have good reasons for wishing that neither one had ever been made.

When you put a Tri-Sure Closure on a drum you provide a "convoy" for every drop in it—a convoy with three weapons that have always won out against leakage, pilferage and waste: (1) a *seal* which cannot be removed unless it is deliberately destroyed; (2) a *plug* which is always held tightly in place; (3) a *flange* which assures complete drainage.

If your job these days is to produce and deliver products that *cannot be wasted or pilfered* a big part of that job is to protect every drum you ship. Let us send you information on the sure way—the 100% safe way—Tri-Sure Closures.

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Soap Mfg. Plant—soda ash

Brewery—malt and grits

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With little or no change in your present buildings or equipment, and without interrupting production, you can obtain the economies and operating advantage of the Airveyor. For unloading and handling dry bulk materials it has many advantages: low storage and handling costs, no loss of material, no dust nuisance, and one-man operation. Conveying lines can be so placed as to not interfere with other plant operations, thus avoiding the expense of delaying production. Different materials can be handled by the same system without contamination.

Airveyors are handling over 60 different materials. Maybe you have a conveying problem that is inefficient and costly. Let us submit an estimate on the necessary equipment to meet your requirements. You don't take chances, because every Airveyor system is sold on guaranteed power costs and capacity.

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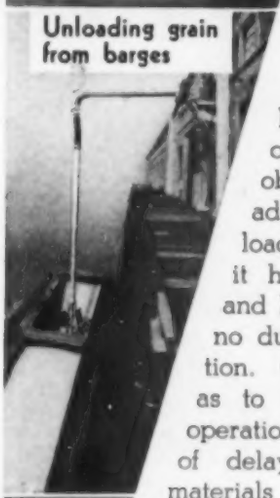
A-50


Unloading grain from barges

Filtration Plant—alum and lime

Apartment House—anthracite ashes

Unloading grain to transfer truck

FULLER COMPANY
CATASAUQUA—PENNSYLVANIA
CHICAGO—Marquette Bldg. SAN FRANCISCO—Chancery Bldg.

nounced recently. Ethyl cellulose when compounded with oil and chemical plasticizers in the range of 40 to 60 percent ethyl cellulose and 60 to 40 percent plasticizer, produces compositions having many of the qualities which have made rubber applicable to numerous products. The new plastic formulation while not suitable for tires and inner tubes as presently developed, would probably be suitable for rubber applications which before the war consumed 60,000 tons of rubber. Qualities of the various formulations are toughness, pliability, flexibility, impermeability, and thermoplasticity. The soft type mixtures can be made to retain good flexibility at temperatures as low as —70 deg. F., a temperature at which most plastics will shatter like glass upon impact. Properties which restrict the application of ethyl cellulose are its limited elasticity and lesser resistance to tearing than rubber. Some formulations have quite good abrasion resistance and tensile strength sufficient for many uses. Water resistance comparable to that of compounded rubbers can be built into these soft-type cellulose plastics. The *G* type ethyl cellulose plasticized with certain plasticizers shows little effect from exposure to gasoline. In general both the *N* and *G* types are unaffected by motor oil. Some formulations show a slight increase in stiffness although not as much as rubber. Strong soap solutions (sodium carbonate) do not harm the plastic.

REPAIR and RESURFACING COMPOUND

One of the new developments is a repair and resurfacing compound with a higher compressive strength than concrete possesses. It will stand up under the heaviest floor loads. It is known as Lev-L-Flor and is made by the Central Paint and Varnish Works, Brooklyn, N. Y. Because of its extreme resiliency, it will not crack and break like concrete or other rigid compounds that are used for patching. It comes ready for instant use. It can be applied without the delaying operation of preparing, chipping and cutting out of the old surface. Lev-L-Flor will fill any crack or broken surface from a feather edge to a hole of any depth inside or outside. It is easily applied and does not require skilled labor. Under ordinary circumstances it may be applied at the end of a day and be ready for heavy surface first thing next morning. It does not harden or deteriorate in the can and may be used time and again until the last bit is gone. For resurfacing one gallon can be spread over 24 sq.ft. $\frac{1}{16}$ in. in thickness.

MAGNESIUM FIRE EXTINGUISHER

Of timely interest is a product for reducing the losses incident to magnesium fires. The new product is called Carey MX Granules, and is manufactured by the Philip Carey Mfg. Co., Lockland, Cincinnati, Ohio. It is claimed by the manufacturer that the

control of magnesium fires with MX Granules is simple and effective. Tests are said to show that, when spread over the fire, these granules soften and seal the burning magnesium with an air-tight blanket, cutting off the oxygen supply and quickly extinguishing the fire. The same principles and methods apply also and with equal effectiveness to extinguishing magnesium incendiary bombs. An added advantage claimed is the large percentage of metal recovered after fire is extinguished. Tests are said to show that when 3 lb. of magnesium alloy scrap were ignited and MX Granules applied to the burning mass, the fire had been extinguished in 5 min, and 2 lb. 5 oz. of the metal recovered. A series of tests conducted by Underwriters' Laboratories, Inc., demonstrated that Carey MX Granules are effective in extinguishing fires in magnesium and magnesium alloys. The granules may be applied to fires with ordinary shovel, or direct from container, without danger to operator. Application of granules does not result in objectionable smoke or soot. Fumes given off disclose no hazardous concentrations of toxic gases. Granules do not absorb an appreciable amount of moisture under normal atmospheric conditions, and may be regarded as non-caking. They remain free-flowing up to 175 deg. temperature and are not adversely affected by exposure to ordinary temperatures.

NATURAL GRAPHITE ADDITIVE

An all-purpose colloidal natural graphite additive for lube oils and many greases is known as Konag "F" made by National Graphite Co., Inc., New York, N. Y. It is said to produce an extremely tough and durable graphoid skin and steps up the lubricating value of oil by providing a better wetted surface by breaking down the surface tension of the oil. For general lubricating purposes, it may be mixed with any general lubricant, at a ratio of 10 percent solution. The correct proportion for any individual problem is easily determined by the engineer in charge.

POTASSIUM SILICATES

Two new grades of potassium silicate have been announced by the Philadelphia Quartz Co., Philadelphia, called Kasil No. 2 and Kasil No. 6. They are specially concentrated solutions, developed primarily for the manufacture of welding rods. One of the most important processes in the welding rod industry is the extrusion method of production which employs potassium silicate of correctly controlled viscosity. Kasil No. 2 is a 32 deg. Bé. product with the molecular ratio of 1:3.92 and Kasil No. 6 is 40.5 deg. Bé. molecular ratio 1:3.29. Both grades are offered at present in steel returnable drums as well as in single trip packages. Other uses for the Kasil potassium silicate include carbon electrodes, paints and applications where non-blooming films are desired.

To acheive a uniform and maximum bond between woven fabrics and those materials employed in chemical processing requires a high degree of fabric uniformity. That's why Mt. VERNON Extra fabrics are definitely a first choice wherever woven fabrics are to become an intrinsic part of such finished products. Highly uniform—made from a top quality of cotton and manufactured to rigid standards of tolerance—these tough and sturdy fabrics contribute to the uniform penetration of chemicals. Behind every yard of Mt. VERNON Extra fabrics is fifty years of industrial fabric making experience. For better processing, and more uniform quality in finished products, specify Mt. VERNON Extra fabrics.

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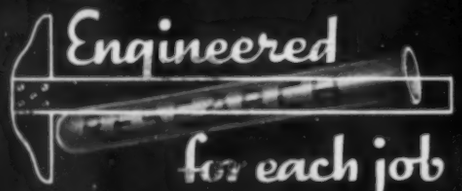
Agents for Victory...

. . . NORTON CATALYTIC CARRIERS GO TO WAR



NORTON ELECTRIC FURNACE FUSED

Electrochemical Society to Hold Convention in October

CHEM & MET NEWS OF MEETINGS & CONVENTIONS

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY MEETS IN BOSTON

THE TECHNICAL Association of the Pulp and Paper Industry in connection with its Fall convention, in Boston, Mass., Sept. 29-Oct. 1, will have an exhibit showing the progress being made by various industries in substituting containers made in whole or part of paper or paperboard for materials essential to the war effort. Any company that is doing its part in aiding the National Government in this way is urged to show its old and new containers or wraps in this exhibit. No charge will be made to any exhibitor since the Association is financing this exhibit as a public relations policy. Sales executives of companies that have any container or other paper product to show are welcome to assist in this public relations job and should write immediately to R. G. Macdonald, Secretary of the Technical Association of the Pulp and Paper Industry, 122 East 42nd St., New York, N. Y.

The Association will also conduct a three-day program devoted to addresses and discussions of war-time packages and other war-time industry problems. It is expected that attendance at the convention and exhibit will total about 800. Sessions will be devoted to war-time packaging, paper industry in war, engineering and the war, the wood pulp industry war-time projects, water conservation and tub sizing. Some 35 technical papers have already been scheduled for these sessions.

ELECTROCHEMISTS TO MEET IN OCTOBER

PLANS FOR the Detroit convention, October 7-10, of the Electrochemical Society are now rapidly being completed. The committee in charge of the scientific and technical program reports the usual large number of manuscripts, nearing 40 in total. For the session on "Modern Trends in Electrodeposition," 15 manuscripts have been received. H. J. Read is in charge of the session on electrodeposition.

For the session on "Theoretical Electrochemistry" of which Malcolm Dole is chairman, there are ten manuscripts. There will also be two luncheon talks of general interest besides a session on miscellaneous topics, including four papers on "Cells and Batteries." Among the visits of special interest will be the one to Greenfield Village, the monument to Edison, the electrochemist and engineer.

AMERICAN SOCIETY OF TOOL ENGINEERS HOLDS WAR CONFERENCE

THE PRODUCTION problems that have arisen in America's first nine months of the war and plans to solve the threatened bottlenecks in war industry due to shortages of critical materials will be discussed at the War Production Conference of the American Society of Tool Engineers at Springfield, Mass., Oct. 16-17. Headquarters of the conference will be at the Kimball Hotel.

Five important sessions, each stressing a vital question that faces war industry today, have been scheduled for the two-day session which will be concluded with a banquet Saturday night. The sessions include those on emergency training, inspection, tool conservation and salvage, war tooling and conversion and materials substitution.

During the past year the organization has increased its membership to almost 11,000 and chartered 16 new chapters. To increase efficiency of operation and prevent the committees from becoming unwieldy, the 64 local chapters and 27 regions have been divided into 7 area groups covering every section of the United States and Canada.

NATIONAL SAFETY COUNCIL CHANGES DATE OF CONVENTION

DATE AND location of the 31st National Safety Congress and Exposition have been changed because the government has taken over for military purposes the Stevens and Congress Hotels in Chicago, where the Congress originally was to have been held.

The 1942 Congress will be held October 27-29 and will be housed in the Sherman, the La Salle and the Morrison Hotels in Chicago. Convention headquarters will be in the Sherman. It is intended that these changes will in no way affect the size, scope and importance of the Congress. There will be 200 sessions with 500 program participants.

JUNIOR CHEMICAL ENGINEERS OF NEW YORK SCHEDULE SPECIAL MEETING

FIRST FALL meeting of the Junior Chemical Engineers of New York, scheduled for Sept. 24, will feature as speaker Richardson K. Wood, former general manager of *Fortune* magazine, originator of Fortune Survey of Public Opinion, and widely-known speaker on chemical trends. Mr. Wood will discuss war-stimulated developments in the chemical field and the influence these will probably have on the post-war world. The meeting will be held at Childs Restaurant, 109 West 42 Street, New York, and dinner will be served at 7:00 p.m. All interested persons are invited to attend.

Newly elected officers and committee chairmen for the organization are as follows: president, John R. Callaham, *Chem. & Met. Eng.*; vice president, Howard Ten Broeck, Socony Vacuum Oil Co.; secretary-treasurer, Alvin S. Weiss, Schenley Distillers Corp.; asst. secretary-treasurer, Edward T. Maples, M. W. Kellogg Co.; publicity, George M. Hain, Joseph Dixon Crucible Co.; program, Raymond P. Devoluy, U. S. Navy Materials Lab.; membership, Frank Melaccio; intersociety activities, Frank B. White, Foster Wheeler Corp.

AMERICAN WELDING SOCIETY PLANS CONVENTION PROGRAM

THE 23RD annual meeting of the American Welding Society will be held during the week of October 12 at the Hotel Cleveland, Cleveland, Ohio. The National Metal Exposition will be in the public auditorium, open afternoons and

CALENDAR

SEPT. 29-30	Technical Association of the Pulp and Paper Industry, Statler Hotel, Boston, Mass.
OCT. 7-10	The Electrochemical Society, fall meeting, Hotel Statler, Detroit, Mich.
NOV. 9-13	American Petroleum Institute, 23rd annual meeting, Palmer House, Chicago, Ill.
NOV. 16-18	American Institute of Chemical Engineers, 35th annual meeting, Netherland Plaza, Cincinnati, Ohio.
NOV. 24-29	National Chemical Exposition and National Industrial Chemical Conference, Sherman Hotel, Chicago, Ill.

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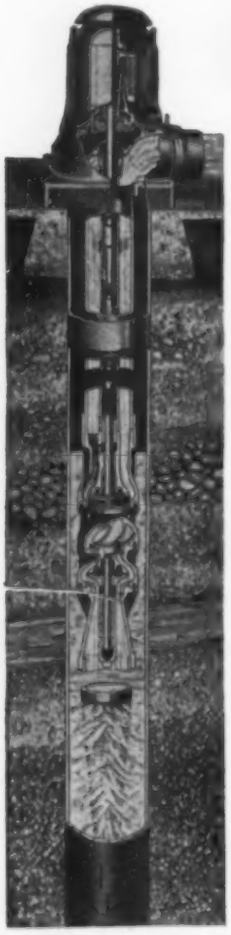

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evenings throughout the entire week.

Many technical papers have been scheduled, among them discussions on training of welding foremen, instruction methods in welding developed by U. S. Office of Education, welding of aluminum, fundamentals of oxy-acetylene welding, gas cutting in steel mills, welding with aluminum bronze, welded steel tubing and its application in war production, methods of increasing welding production and decreasing welding costs, preparation of aluminum alloys for production spot welding, and many others.

TECHNICAL MEETINGS NOW BEING SCHEDULED

AMONG THE TECHNICAL association meetings and conventions of interest to chemical engineers and industrial chemists now being planned for the fall months are the following:

National Petroleum Association, annual meeting, Hotel Traymore, Atlantic City, N. J., Sept. 16-18.

Technical Association of the Pulp and Paper Industry, Statler Hotel, Boston, Massachusetts, Sept. 29-30.

American Gas Association, annual meeting, La Salle Hotel, Chicago, Ill., Oct. 5-6.

American Oil Chemists' Society, Drake Hotel, Chicago, Ill., Oct. 7-9.

National Safety Congress and Exposition, 31st annual meeting, Sherman Hotel, Chicago, Ill., Oct. 27-29.

Electrochemical Society, fall meeting, Hotel Statler, Detroit, Mich., Oct. 7-10.

American Welding Society, 23rd annual meeting, Hotel Cleveland, Cleveland, Ohio, Oct. 12-16.

American Society of Mechanical Engineers, fall meeting, Rochester, N. Y., Oct. 12-14.

American Society of Tool Engineers, semi-annual meeting, Springfield, Mass., Oct. 16-17.

American Petroleum Institute, 23rd annual meeting, Palmer House, Chicago, Ill., Nov. 9-13.

American Institute of Chemical Engineers, 35th annual meeting, Netherland Plaza, Cincinnati, Ohio, Nov. 16-18.

National Chemical Exposition and National Industrial Chemical Conference, Sherman Hotel, Chicago, Ill., Nov. 24-29.

American Society of Mechanical Engineers, annual meeting, New York, N. Y., Nov. 30-Dec. 4.

American Institute of Mining & Metallurgical Engineers, 157th annual meeting, New York, N. Y., Feb. 15-18, 1943.

SELECTIONS FROM CONVENTION PAPERS

PRESENT DEMAND AND OUTLOOK FOR INSECTICIDES

ENTOMOLOGISTS estimate that about 7,000 species of insects in the United States attack growing crops, stored grain, dried fruits, nuts, flour, tobacco, woolen clothing, wooden buildings, domestic animals and even man himself. The damage caused is not less than two billion dollars annually in addition to one billion dollars of damage caused by fungi and bacteria that attack vegetables, fruits, and grain.

Present demand for principal insecticides is shown by the statistics of their consumption in the United States for 1941. Available information indicates that 1942 consumption will equal that of 1941, which was the highest on record.

Synthetic Insecticides—Among the synthetic organic compounds being used on an increasing scale for insecticidal purposes are phenothiazine, cyclohexylamine, tetramethylthiuram disulphide and xanthone. A number of wetting and emulsifying agents, such as sodium lauryl sulphate and other sulphated or sulphonated organic compounds are used in conjunction with insecticides. Certain compounds have recently been discovered to have synergistic action when added to pyrethrum extract dissolved in kerosene. Examples are isobutyl undecyleneamide and sesamin from sesame oil.

Laboratory tests have indicated that phenothiazine is not only more toxic than rotenone to mosquito larvae but as effective as lead arsenate in controlling codling moth larvae. It has also been found to be toxic to the tent caterpillar, Mexican bean beetle, European corn borer and several other insects. Phenothiazine has fungicidal values against apple scab and has proved to be the most useful anthelmintic for treatment of animals. In 1941, more than 2,000,000 pounds of phenothiazine were used for treatment of domestic animals alone in the United States.

Laboratory insecticidal tests indicate that xanthone is toxic to the mosquito and codling moth larvae, the diamondback moth, Southern armyworm, and termites. This material, controlled by patents just issued to the U. S. Department of Agriculture, has recently been made available in quantity under the name "Genicide" and has been tested against codling moth larvae under field conditions.

When consumption of insecticides is figured on a basis of lbs. per acre and total crop acreage, it is seen that the amount used is very small in comparison with potential use. For the control of the boll weevil, calcium arsenate is recommended at the rate of 4-6 lb. per acre applied three or more times. In 1940 there were in cultivation in the United States 24,871,000 acres of cotton which would require a minimum of

U. S. Consumption of Principal Insecticides in 1941

	Tons
Arsenicals	
Lead arsenate	35,000
Calcium arsenate	35,000
Paris green	1,000
Sodium arsenite	7,500
Antimony	
Tartar emetic	50
Copper	
Copper oxides, basic carbonate, phosphate silicate, Bordeaux mixture, etc. (as copper sulphate, $CuSO_4 \cdot 5H_2O$)	40,000
Mercury	
Organic mercury seed disinfectants (as metallic Hg)	42
Fluorine	
Cryolite	2,500
Sodium fluoride	450
Sodium fluosilicate	1,000
Sulphur	
Sulphur dusts	45,000
Lime—sulphur solution (gallons)	5,000
Insecticides of vegetable origin	
Nicotine sulphate	1,500
Derris, cube, and timbo	4,000
Pyrethrum flowers	6,000

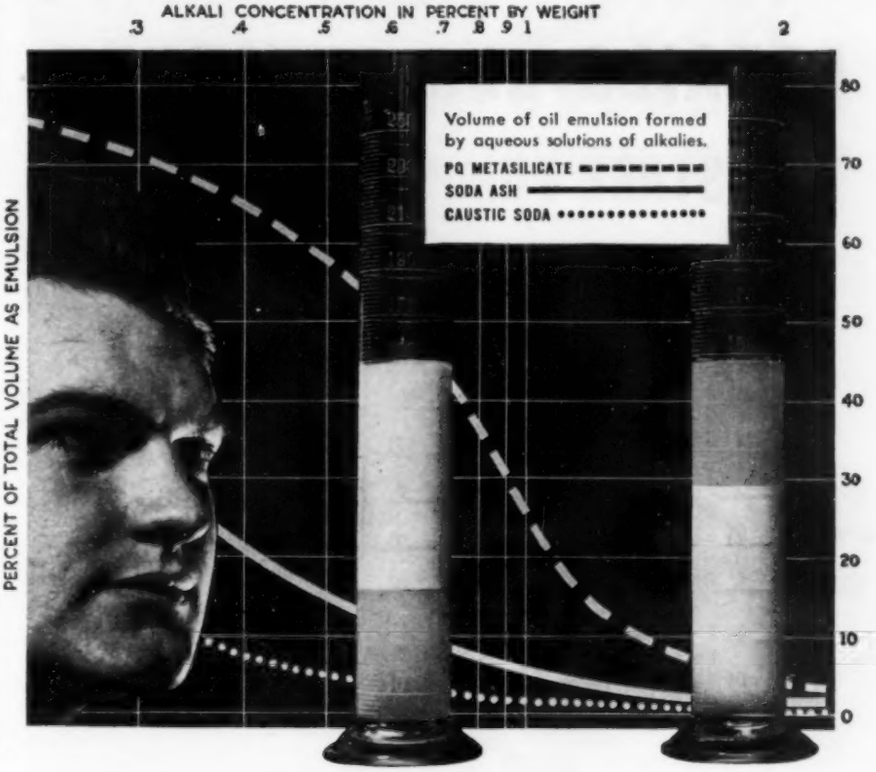
298,452,000 lb. of calcium arsenate if the entire acreage were dusted. This is over four times the maximum ever produced.

Mexican Sources—Among the possible Mexican sources of insecticides is the cucaracha plant, a native of northern Mexico reputed to be an effective insecticide against household pests. The active principles of this plant have not been identified. The tree tobacco contains anabasine which is 4-5 times as toxic as nicotine upon the bean aphid.

U. S. Crop Distribution of Certain Insecticides in 1941

	Pounds		
	Lead arsenate	Nicotine sulphate	Copper sulphate
Apples	35,000,000	675,000	18,900,000
Apricots	200,000	.....	35,000
Asparagus	25,000	.....	.....
Avocados	.....	.....	70,000
Beans	.....	.....	630,000
Beets	.....	.....	630,000
Blackberries	.....	.....	10,000
Broccoli	.....	25,000	.....
Cabbage and other cole crops	1,000,000	87,000	.....
Cantaloupes	.....	25,000	735,000
Carrots	.....	.....	70,000
Celery	.....	25,000	1,575,000
Cherries	600,000	.....	315,000
Citrus	.....	5,000	1,575,000
Cotton	1,500,000	32,000	.....
Corn	.....	2,000	.....
Cranberries	670,000	.....	787,500
Cucumbers	.....	15,000	588,000
Eggplant	.....	1,000	10,000
Grapes	3,000,000	50,000	3,937,500
Hops	.....	37,000	.....
Horseradish	.....	.....	70,000
Lettuce	.....	.....	70,000
Mushrooms	.....	5,000	.....
Onions	.....	5,000	70,000
Peaches	6,000,000	.....	35,000
Peanuts	.....	.....	70,000
Peas	.....	78,000	.....
Pears	3,000,000	125,000	1,260,000
Pecans	.....	.....	70,000
Peppers	.....	2,000	.....
Plums and prunes	100,000	25,000	157,500
Poppyseed	.....	.....	70,000
Potatoes	1,000,000	5,000	34,364,500
Quinces	.....	.....	70,000
Raspberries	.....	.....	10,000
Spinach	.....	5,000	.....
Strawberries	100,000	.....	70,000
Sweetpotatoes	.....	.....	70,000
Tobacco	1,000,000	.....	70,000
Tomatoes	250,000	5,000	2,520,000
Turnips	.....	11,000	.....
Vetch	.....	25,000	.....
Watermelons	.....	30,000	735,000
Crops grown in greenhouses	.....	.....	70,000
Domestic animals	.....	500,000	.....
Forests	1,000,000	.....	.....
Home gardens and orchards	8,555,000	500,000	105,000
Lawn and golf greens	1,000,000	.....	.....
Nurseries	2,000,000	.....	.....
Shade trees and ornamentals	4,000,000	200,000	105,000
Totals	70,000,000	2,500,000	70,000,000

SOLUBLE PQ SILICATE CLEANERS


ALKALI CONCENTRATION IN PERCENT BY WEIGHT
.3 .4 .5 .6 .7 .8 .9 1 2
PERCENT OF TOTAL VOLUME AS EMULSION
Volume of oil emulsion formed by aqueous solutions of alkalies.
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SODA ASH
CAUSTIC SODA
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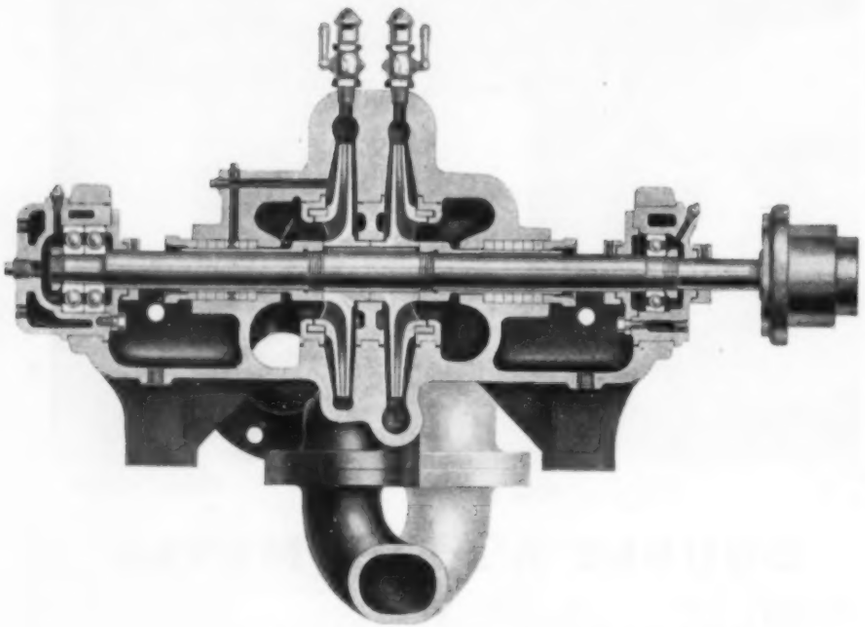

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CASING: **Horizontally split, permitting easy inspection or repairs without disturbing alignment or pipe connections.**

SHAFT: **Ample diameter to safely transmit required power without undue bending or twisting.**

CASE RINGS: **Nozzle type, held in place by tongue and groove lock joint . . . eliminates use of pins or screws for fastening.**

CENTER SECTION: **Reduces interstage leakage; protects casing from wear.**

BEARINGS: **Oversize . . . produces long life and greater protection against overloads.**

GLANDS: **Split type, easily removable, facilitating ease in repacking.**

TESTING: **All pumps are tested under actual working conditions and at temperature of fluid handled.**

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This species grows wild in northern Mexico and the southwestern United States.

Outlook for growing insecticidal plants in Mexico, Central America, and South America appears especially bright. Lonchocarpus, derris, and other plants that contain rotenone can be grown in tropical countries. In 1940 the United States imported 6,500,000 lb. of rotenone-bearing roots. The present potential market is at least 30,000,000 lb. Pyrethrum flowers, of which the United States imported 20,000,000 lb. in 1937, should grow well in the high plateaus of Mexico. At present almost the entire world production is grown in eastern Africa.

R. C. Roark, Division of Insecticide Investigation, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Washington, D. C., contributed to the Second Inter-American Conference of Agriculture, Mexico City, July 6–16, 1942.

ANODIC AND SURFACE CONVERSION COATINGS ON MAGNESIUM

MAGNESIUM OXIDE and hydroxide are sparingly soluble in water (about 0.01 g./L. Mg.) but the solubility increases some 50 times in water containing CO_2. Even though the surface layer of magnesium is converted to MgO by anodic oxidation the probability remains that the oxide, by contact with water vapor or water, will be converted to hydroxide and in the presence of CO_2 or carbonates, may be changed to carbonate and bicarbonate.

It is significant that the fluoride, phosphate and silicate of magnesium are compounds of relatively low solubility. Magnesium is relatively insoluble in NaOH, whereas the reverse is true with aluminum. A further difficulty in the preparation of protective coatings on magnesium is the fact that magnesium chromate is very soluble; chromic acid and dichromates dissolve MgO. However, chromates do inhibit the corrosive action of magnesium and are a constituent of many coating solutions.

No oxide coating methods have been developed for magnesium which are as effective as those used on aluminum. The reasons may be due to differences in chemical behavior of the two metals and their oxides, and also in the properties of the coatings themselves. Aluminum oxide is hard and abrasion-resistant and may be produced as continuous, impervious films. On the other hand, MgO is a soft material and since its molecular volume is substantially

. . .

"Last year industry asked for four times as many young engineers as the universities and technical schools could provide. This year the need will be greater, and next year it promises to be greater still. In deciding where they can make their best contribution to the nation's war effort, therefore, engineering students should consider the needs of industry as well as the attractions of the armed services."

less than that of the metal from which it is formed, there is a tendency in anodic oxidation of magnesium to form discontinuous films. Also, because of their reactivity with water and various anions in the coating solutions, the coatings are likely to be converted from the original oxide film to a reaction product which may be either better or inferior in its protective properties.

Anodic Coating—Many electrolytes have been tried for the anodic coating of magnesium, but with only limited success. Some of these have been decidedly alkaline in reaction, such as solutions of NaOH, KOH, aluminates, carbonates and silicates. Other electrolytes have been mildly acid or alkaline in reaction, such as solutions of chromates, fluorides or phosphates. With all, the difficulty has been to secure adherent and protective coatings. Subsequent treatments with solutions of chromates or silicates have been found helpful in some cases.

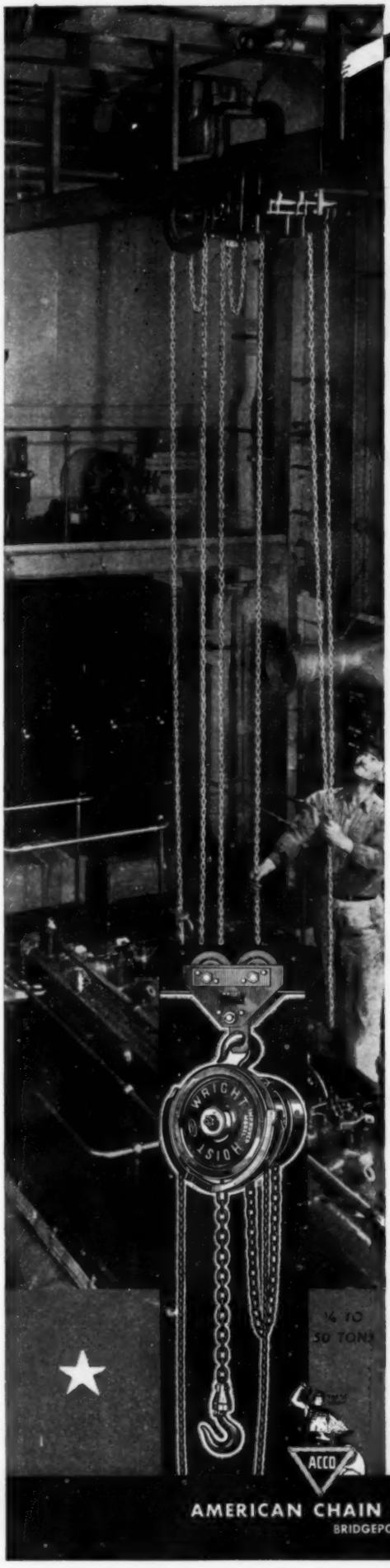
One of the best of these anodic treatments is that proposed by Buzzard and Wilson at the National Bureau of Standards. Their electrolyte is an acid mixture (pH 4.0—4.8) of dichromate and phosphate; a preferred bath contains about 10 percent of $Na_2Cr_2O_7.2H_2O$ and from 2.5 percent $NaH_2PO_4.H_2O$. After careful preliminary cleaning or

Coatings on Magnesium by Chemical Treatment

Commercial Name of Coating	Composition of Coating Solutions*	Treatment		Comments
		Time minutes	Temp. of Solution	
Dichromate-dip or chrome-pickle	Sodium dichromate, 1.5 lb., nitric acid conc., 1.5 pt. per gal.	¼ to 2	70 to 150°F.	(1)
Chrome-sulfate	Magnesium sulfate, 8 oz., sodium dichromate, 6 oz. per gal.	15	150 to 160°F.	(2)
HF-dichromate	Hydrofluoric acid, 15-20%, followed by sodium dichromate, 10%	5 45	Room Boiling	(3)
Galvanic-anodize	HF, 15-20%, followed by galvanic anodising ammonium sulfate, 3%, sodium dichromate, 0.25%, ammonia, sp. gr., 0.88	5 30	Room Room	(4)
Sealed chrome-pickle	Chrome pickle followed by sodium dichromate, 10%	(See A) 30	(See A) Boiling	(5)
Pressure	Sodium hydroxide, 10%	1 to 5 or 30	390 to 400°F.	(6)

COMMENTS: (1) Yellow to brown color. Prevention of tarnishing; paint base. All magnesium alloys. Dimenisonal change, —0.001 in. (0.025 mm.). (2) Yellow color. Low dielectric strength. All magnesium alloys. No dimensional change. (3) Deep brown color. Paint base or protective coating of some decorative value in interior application. All magnesium alloys except AM38. No dimensional change. (4) Dark gray to black color. Paint base for exterior and marine applications. All magnesium alloys. No dimensional change. (5) Iridescent red to yellow. Paint base especially for welded sheet parts. All magnesium alloys. No dimensional change after first step. (6) Gray to dark brown color. Hardest coating available for magnesium alloys. All except die castings; wrought alloys preferred. Increase in dimensions, 0.001 in. (0.025 mm.). May be dyed.

*These treatments are frequently preceded by a cleaning treatment and washing or rinsing is employed between steps and after final treatment prior to drying.



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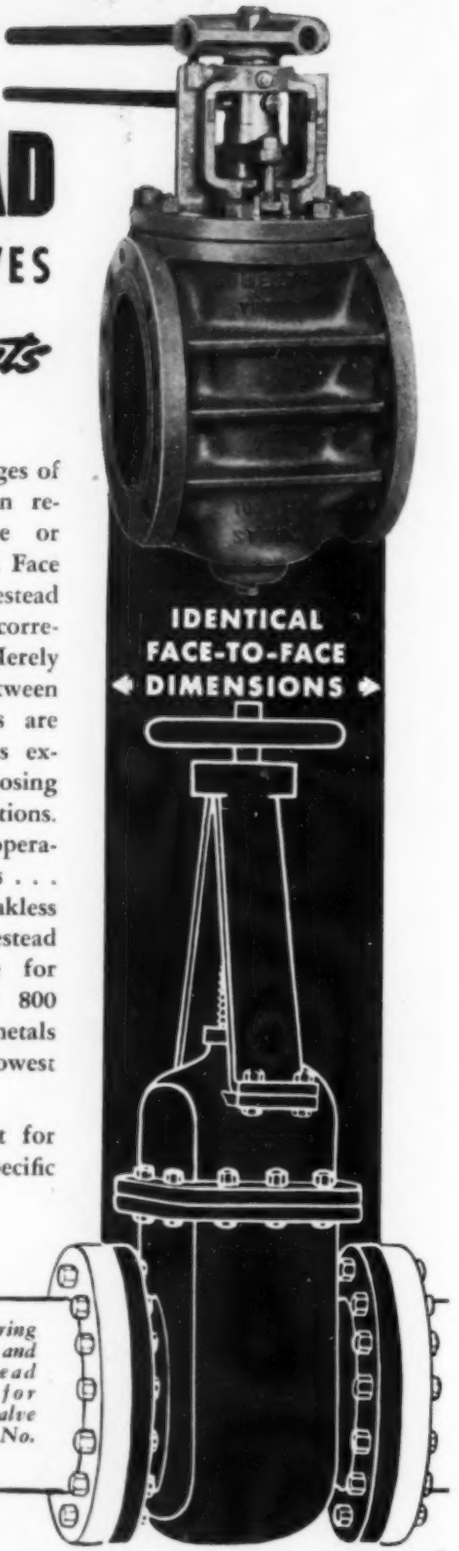

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pickling, the magnesium article is made anode, the current density adjusted to a value of 5-10 amp., with the electrolyte at a temperature of about 50 deg. C., and treatment continued for a period of 30-60 min. While the coating is thin, it offers good surface protection when used in combination with suitable paint coatings.

Chemical Coating—Formation of protective coatings on magnesium by chemical treatment has become almost universal where such a coating is needed. In fact, it is routine practice to give most castings and forgings the treatment known as "chrome-pickle" before they leave the fabricating plant. A great variety of surface treatments have been proposed but practice is gradually decreasing the number in actual use. It is significant that most of the methods employ chromic acid or chromates. It is probable that reduced chromium compounds are included in many of these coatings. Some of the methods are preferred for use on machined surfaces, for example, because they do not remove enough metal to seriously affect the dimensions of the piece. Other methods may be selected to provide a base for paints or for decorative purposes.

In the attached table are outlined a number of the good chemical treatments employed for coating magnesium and its alloys. The magnesium article is electrically connected to the steel tank or to a steel cathode plate in the process known as galvanic-anodizing. The choice will depend on a number of factors, including the composition of the alloy to be treated. Suitable cleaning of the surface prior to chemical treatment is considered quite important. To secure the best protection on any magesium alloy requires the selection of the best surface treatment, followed by an adequate painting.

Primers made with phenolic resin varnishes of short to moderate oil length and pigmented with zinc chromate are excellent. They should be followed by aluminum-pigmented finishing coats in phenolic resin varnishes of moderate oil length. Using this practice, satisfactory protection has been obtained on the more corrosion-resistant alloys for periods up to 3-4 years in exposure tests at the sea coast. With similar panels in industrial atmospheric exposure tests, exposures of 5-6 years without noticeable signs of failure have been obtained.

Junius D. Edwards, Aluminum Research Laboratories, New Kensington, Pa., before the Electrochemical Society, Nashville, Tenn., April 15–18, 1942.

MANUFACTURE OF SILICA AEROGEL

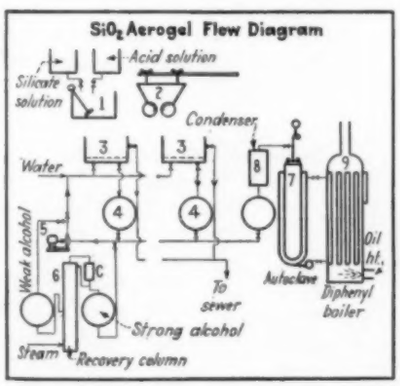
SILICA AEROGEL has recently assumed commercial significance and pilot plant operations have been concluded. The first large scale production unit is now being operated. The process is built around one essential unit operation involving the more or less unique step of heating a gel system to temperatures and pressures above the criticals for the liquid phase present in the gel.

If the gel is heated under sufficient pressure to prevent evaporation within the gel, then no gas phase forms until the critical temperature of the liquid is reached. At this point the liquid phase may be said to be converted to the gaseous phase instantaneously, thus avoiding a gas-liquid interface. Once the gas phase has been reached, the gas may be withdrawn without causing any collapse of the solid structure. The resultant product is a light, friable, opalescent solid containing as much as 95 percent air by volume. Silica aerogels having densities as low as 1.8 lb. per cu. ft. have been produced. Since colloidal SiO_2 undergoes a change in the presence of water at elevated temperatures, resulting in greatly increased particle size, the water is replaced with C_2H_5OH before the autoclaving operation.

Description of Process—Reference is made to the schematic flow diagram shown in the accompanying figure. Sulphuric acid and $Na_2O \cdot SiO_2$ solutions of suitable dilutions are mixed in tank (1), the $Na_2O \cdot SiO_2$ being added to the H_2SO_4. Concentrations are controlled to yield a gel having 8 percent SiO_2. After aging several hours to allow the gel to strengthen, due to syneresis phenomena, it is removed from (1) and passed through the roll crusher (2) into one of four wash tanks (3). Water is passed up through this tank over the gel to remove the Na_2SO_4 formed in the gel preparation reaction. When the gel has been sufficiently washed, all excess water is removed by draining. The gel is then covered with alcohol.

After a suitable soaking time the C_2H_5OH is drained off and replaced with a fresh portion. This washing procedure is accomplished by use of a conventional 4-stage counter-current system. Greater economy of C_2H_5OH is realized by using the cover, soak and drain method of washing in place of continuous flow through the tanks. The counter-current cycle is facilitated by use of the wash receivers (4) and the transfer pump (5). Weak alcohol taken from the system is recovered as strong alcohol by fractionation in a recovery column (6).

When the water in the gel has been substantially replaced with alcohol, excess C_2H_5OH is drained off and the gel charged to the autoclave (7). Here it is heated to 550 deg. F., the pres-



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THREDOLETS

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How to cut the cost of right-angle branch pipe outlets

THE most costly part of any piping installation is the labor and materials required to make branch pipe outlets. Bonney Weldolets, Thredolets and Socket-End WeldOlets will keep that cost to a minimum.

Using these fittings, installing them either by electric-arc or oxy-acetylene welding will reduce the cost of right-angle branch pipe outlets from 10 to 35% when compared to the cost of making similar outlets with threaded tees or pipe-to-pipe intersection welds.

Bonney WeldOlets, ThredOlets and Socket-End WeldOlets provide other advantages impossible to obtain by using other methods to make similar types of outlets. Because they are installed by welding, they eliminate all cutting, threading or fitting of the main pipe. Because of their patented design they provide an outlet of full pipe strength that is absolutely leakproof and which, because of its funnel-shaped intake aperture, reduces friction and turbulence to a minimum.

WeldOlets, ThredOlets and Socket-End WeldOlets eliminate the necessity for templets and preliminary layout of the main and branch lines. The fitting itself is used as a templet.

Standard stock fittings (outlets from ¼" to 12") in size-to-size and reducing sizes are drop forged steel. For special applications, or where unusual conditions exist, they can be supplied in Toncan Iron, wrought iron, brass, Monel, Everdur, etc. and in sizes up to 24" x 24". WeldOlets, ThredOlets and Socket-End WeldOlets are suitable for every type of piping installation and for all commonly used pressures and temperatures.

Your local distributor will be glad to tell you the complete story about savings which can be affected—or, write for Bulletin WT31—TODAY.

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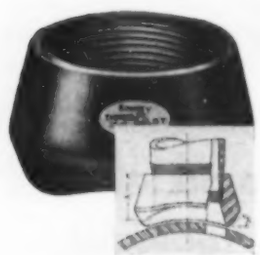
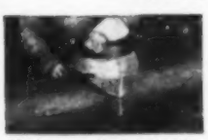


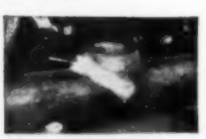
THREDOLET

Socket-End WELDOLET

EASILY INSTALLED

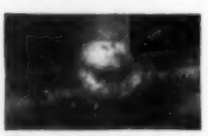


Mark center lines and tack the fitting into place.



Then weld the fitting to the main pipe.

Remove the button, which will also permit inspection of the inside of joint.



Then attach the branch pipe.

Bulletin WT31—just off the press—a 16 page catalog covering every feature of these fittings in complete detail and showing many of the various types of installations on which they have been made.

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FORGED FITTINGS DIVISION

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sure being held to 1,150 lb. gage by bleeding off alcohol vapor through the condenser (8). When 550 deg. F. is reached, the pressure is reduced to atmospheric and the autoclave is finally evacuated to 20 in. Hg. for 10 min. The resultant aerogel is then removed by an airveyor system. The autoclave is heated by a jacket containing diphenyl vapor at 80 lb. gage pressure, this vapor being supplied by the oil fired diphenyl boiler (9).

Autoclaving Operation—It has been found impractical to substitute C_2H_5OH completely for water originally in the gel. Experiments showed that aging of SiO_2 does not take place at a significant rate providing the liquid phase contains above 85 percent C_2H_5OH. Therefore the alcohol washing operation is designed to produce an alcogel having a liquid phase containing approximately 87 to 89 percent C_2H_5OH. The critical temperature of this system was established. The critical pressure has not been determined, but operation at 1,150 lb. gage has been selected as standard, this being found experimentally to be the lowest satisfactory pressure. Therefore, conditions of the autoclaving operation are 250 deg. C. at 1,150 lb. pressure.

John F. White, research department, Merrimac Division of Monsanto Chemical Co., Boston, Mass., before the Joint Symposium of the American Institute of Chemical Engineers with the Heat Transfer Division of the American Society of Mechanical Engineers, Boston, Mass., May 11–13, 1942.

ELECTROTHERMAL FERRO-ALLOY PRODUCTION IN BRAZIL

EARLY IN 1941 it appeared that, owing to opportunities available in South America and the desire of our federal government to develop closer relations with the South American Republics, it would be wise to investigate the possibilities of industrial developments on that continent. Accordingly in August, 1941, Guy L. Tinkham, an American citizen, was sent to Brazil to study its economic, industrial and social conditions with the view of developing certain natural resources.

This report relates specifically to the production of ferro-alloys and the quantity of water power necessary to supply the electrical energy for such development. Estimated operating costs and suggestions are presented as to the design of a ferro-alloy plant for (1) immediate installation or (2) ultimate installation. Earnings of such a plant are ample to justify the expenditure required and the procedure outlined will open up new resources of mate-

Suggested Initial Installation

Product	No. Furnaces	Hourly Power Consumption kwh.	Approx. Daily Output Lb.	Approx. Daily Output Est. Value
Ferromanganese (80%)	1	3,000	40,800	$2,440.00
Ferrochrome (70%)	1	500	4,000	364.00
Ferrotungsten (70%)	1	500	2,000	2,800.00
Total	3	4,000	46,800	$5,604.00

Ultimate Plant Estimated Spread between Selling Price and Operating Cost

Product	Est. Gross Cost per Lb.	Present Selling Price per Lb.	Total Lb. per Day	Est. Daily Margin
Ferromanganese (80%)	$0.043	$0.070	40,800	$1,100.00
Ferrosilicon (50%)	0.0235	0.04	34,320	560.00
Ferrochromium (70%)	0.051	0.091	16,000	640.00
Ferrotungsten (70%)	0.97	1.40	4,000	1,720.00
Calcium carbide	0.32	0.05	24,000	430.00
Silicon carbide	0.049	0.08	16,000	490.00
Electric cast iron	0.046	0.07	12,000	290.00
Total			147,120	$5,230.00

rials which have a place in the present war. The plant may be operated advantageously after the war for the production of numerous items which will have a definite place in the peacetime economy of Brazil. Most of these products would be of a type difficult to import and could be best made locally in Brazil. Because of the above conditions, the operation of the proposed electric furnace plant, either initially or ultimately, would not involve serious competition to American manufacturers.

Raw Materials—A preliminary study of raw materials now available in Brazil indicates that the basic materials necessary for the production of ferromanganese, ferrosilicon, ferrochrome and ferrotungsten are available and apparently in more than sufficient quantities to justify the initial installation. Iron ore, manganese ore and high grade silica rock are available in practically unlimited quantities in the state of Minas Geraes close to the suggested site of the plant. Limestone required to slag the silica (when making ferromanganese) is present in abundant quantities in Minas Geraes, at Carandahy, Lagoa, Ceraruama and near Cabofrio.

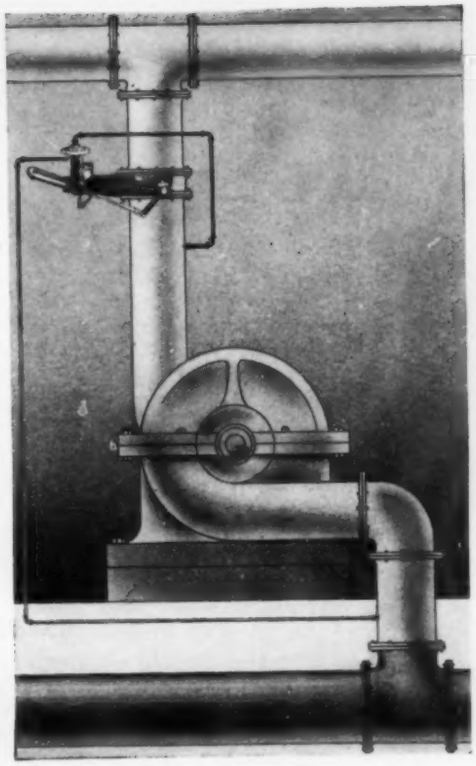
Fluorspar for fluxing is probably not available in large quantities. However, it is possible to smelt ferro-alloys without fluorspar, using cheap alkali salts as fluxes. These are available in ample quantities at Cabofrio.

Some form of carbon is required as a reducing agent. Coal or coke may be used but these are not readily available in Brazil. Charcoal, however, is available in large quantities and is one of the finest reducing agents for manufacture of ferro-alloys. The base price per ton of charcoal in Brazil

Suggested Ultimate Installation

Product	No. Furnaces	Hourly Power Consumption kwh.	Approx. Daily Output	
Ferromanganese (80%)	1	3,000	40,800	$2,440.00
Ferrosilicon (50%)	1	3,000	34,320	1,370.00
Ferrochromium (70%)	2	2,000	16,000	1,450.00
Ferrotungsten (70%)	2	1,000	4,000	5,600.00
Calcium carbide	1	2,000	24,000	1,200.00
Silicon carbide	1	3,000	16,000	1,280.00
Electric cast iron	1	1,000	12,000	720.00
Total	9	15,000	147,120	$14,060.00

125-lb R-S Butterfly Valve, equipped with hydraulic cylinder for automatic operation, serves a triple purpose where a pump or battery of pumps discharges into a common header. Prevents a synchronous-driven pump from grabbing all the load when the pump is started, prevents reverse flow through the pump and eliminates water hammer.



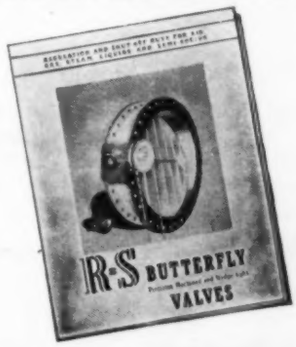
AUTOMATIC BUTTERFLY VALVE

• Protects Pumping Unit
• Prevents Water Hammer

For example, with 55 p.s.i. in the common header and a 2 lb. lift, a differential control, utilizing the hydraulic cylinder, would be set for approximately 56 lbs. The Butterfly Valve remains open as long as a greater differential than 56 lb. is maintained.

In case of pump or power failure, the flow through the pump reverses. The natural tendency of an R-S Valve is to close itself under a pressure drop. The differential now drops below 56 lbs. and the cylinder closes the valve wedge-tight. It will remain closed until the pressure differential is regained. When this takes place, the valve opens gradually and normal pumping operations are resumed.

Closing of the valve causes no water hammer since the valve can not move any faster than the bleeding of the cylinder discharge permits.



Declutching unit with self-locking hand wheel control also available. Sizes to 84-inches and presures to 600 lbs.

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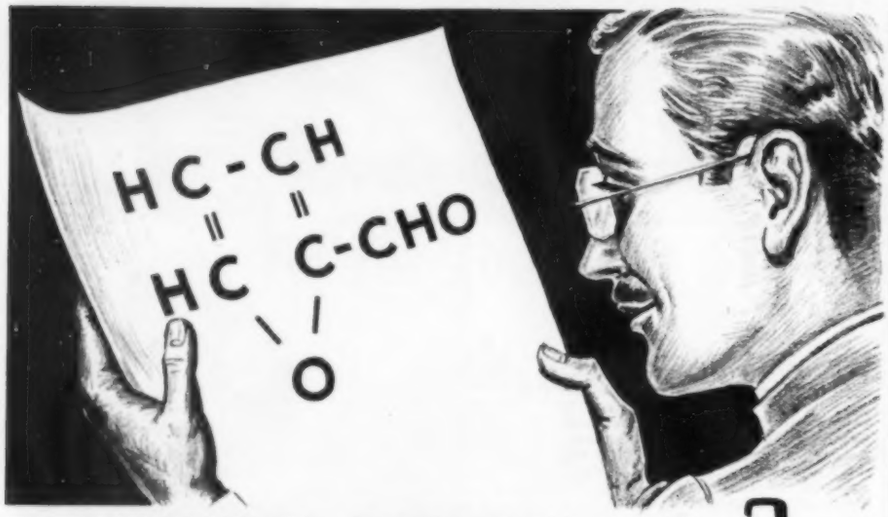

WHAT HAPPENS ?

THE DIAGRAM shows the structure of Furfural, a heterocyclic aldehyde useful in a variety of ways due to its unique characteristics.

For example, one of the major uses of Furfural involves reactions with a number of materials to form resins with highly desirable properties. These reactions take place with phenol, acetone, aniline, urea and a number of other materials. Furfural resins are economical to make and have excellent moisture resistance, electrical properties, and mechanical strength.

When used as a solvent for resins, dyes and preservatives, Furfural acts as an aid to penetration and wetting. In the resinoid bonded grinding wheel industry it has no peer and practically all wheel manufacturers use Furfural in their production.

Furfural is an aldehyde and exhibits the general properties of this class of compounds. It can be reduced to alcohols, and oxidized to acids. When treated with strong caustic, it undergoes the Cannizzero reaction, forming Furfuryl Alcohol and Sodium Furoate. The latter can be used to make Furoic Acid.

Other applications involve its use as a selective solvent in the refining of lubricating oil, diesel fuel, and crude wood rosin.

Typical properties of the commercial product are:

Specific gravity (20/20)	1.161
Boiling point	157–167°C.(99%)
Flash point (open cup)	56°C.
Surface tension (dynes/cm)	49
Viscosity at 38°C. (centipoises)	1.35

Investigate the possibilities of using Furfural today. It will pay dividends.

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FURFURYL ALCOHOL

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HYDROFURAMIDE

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amounts to about $7.50 or about 25 percent the price in the United States.

Chrome ore is available in several localities in Minas Geraes, with larger developments in Bahia to the north. It is reported that water transportation is available for chrome ore (San Francisco River). The known deposits of chrome ore relatively close to the proposed plant site have not yet been fully explored so that initial operations should be based on the assumption that chrome ore will be brought in from Bahia.

Tungsten ore has not yet been located in quantities in Minas Geraes but is already in production south of Rio. It is now being shipped out of Brazil and the proposed operation would save on freight shipments by permitting the transport of a finished product, ferrotungsten. Since tungsten ore commands a relatively high price, the cost of transportation is a negligible percentage of the selling price.

Labor and Power—Labor rates in Brazil are extremely low, based on comparisons with those of the United States. A day rate of 25 cents would represent an average for ordinary labor. Skilled supervision rates range from $0.60-1.00 per day.

Electric power from the Parauna Falls plant is now being sold at about 0.4 cents per kw.hr. in small quantities. Large blocks bring a lower rate. For the operation of the electric furnace plant in question, a substantially lower rate could undoubtedly be obtained.

Electric Cast Iron—Equipment which would be installed in the proposed Brazilian plant could be utilized for electric melting of iron or steel, or reduction of iron ore to cast iron. Ferro-silicon would then be added to the melted iron. The result would be a controlled grade of cast iron which would have a large market in Brazil in view of the present scarcity of this product. This is suggested as an item to be considered in the ultimate plant layout.

Capital Investment—It is estimated that the initial plant installation would represent an investment of around $650,000 including buildings, bins, auxiliary equipment erected plus the furnace equipment specified. It is estimated that the cost of the additional ultimate installation based on present prices would amount to around $1,422,000. This would make the estimated total investment required around $2,064,000 based on present prices.

W. A. Darrah, president, Continental Industrial Engineers, Inc., Chicago, Ill., before the Electrochemical Society, Nashville, Tenn., April 15–18, 1942.

FATIGUE TESTING OF ZINC-BASE ALLOY DIE CASTINGS

FATIGUE TESTS were conducted on die-cast specimens of several zinc-base die-casting alloys to satisfy the occasional demands for these values. The work described was carried out over a period of eight years by the Research Division of the New Jersey Zinc Co. (of Pa.).

Specimens were subjected to three aging conditions before testing: 6 months at room temperature; 6 hr. in 95 deg. C. dry air; and 5 days in 95 deg. C. steam.

Testing was done at 25±1 deg. C. at a speed of 1600 cycles per min. in a flexure-type machine. The majority of specimens were 0.25 in. thick but a few were 0.125 in. thick. The results were checked superficially by rotating cantilever-beam tests. The endurance limit was arbitrarily chosen as the greatest stress not causing failure at 100,000,000 cycles. Each point on the *S-N* curve was the first failure in a 20-specimen test at the same stress.

Since 20 specimens were tested under each set of conditions and since the endurance limits were derived from the first failure in each test group (that is, the poorest specimen of the 20 tested), the above figures are conservative and a safety factor of 1.20 to 1.30 should be adequate for engineering calculations.

Treatment	Endurance Limit, lb. per sq. in. Zamak-2	Zamak-3	Zamak-5
Aged 6 months at room temperature	8,500	6,875	8,175
Annealed 6 hr. in dry air at 95 C	8,000	6,500	7,675
Exposed 5 days in 95 C. steam tank	6,200	5,950	5,700*
	Tensile Strength		
As die cast	52,100	41,000	47,600

* Extrapolated value.

Above data were checked with a small number of flexure fatigue tests on 0.125-in. thick specimens. These failed to indicate any significant effect due to differences in specimen size. The few rotating-beam tests indicated only that the flexure fatigue data were on the conservative side.

E. H. Kelton, Research Div., New Jersey Zinc Co. (of Pa.), Palmerton, Pa., before the 45th annual meeting of the American Society for Testing Materials Atlantic City, N. J., June 22–26, 1942

FERTILIZER BY FUSION OF ROCK PHOSPHATE WITH OLIVINE

IT WAS FOUND that by fusion of a mixture of rock phosphate, magnesia, and silica with subsequent rapid cooling of the melt, it is possible to make a product which has a high proportion of its P_2O_5 content soluble in citrated ammonium nitrate solution. Olivine, a mineral magnesium silicate found in abundance in the Tennessee Valley, is a suitable and economical source of magnesia and silica for the fusion process.

Fusion of a mixture of 1 lb. of rock phosphate and 0.46 lb. of olivine yielded a product containing 22.8 percent total P_2O_5 and 21.4 percent soluble P_2O_5. From 25-33 percent of the fluorine in the rock phosphate was volatilized in the process. Plant growth tests indicated that the product was practically as effective a source of P_2O_5 as superphosphate.

Because of the cheapness of the raw

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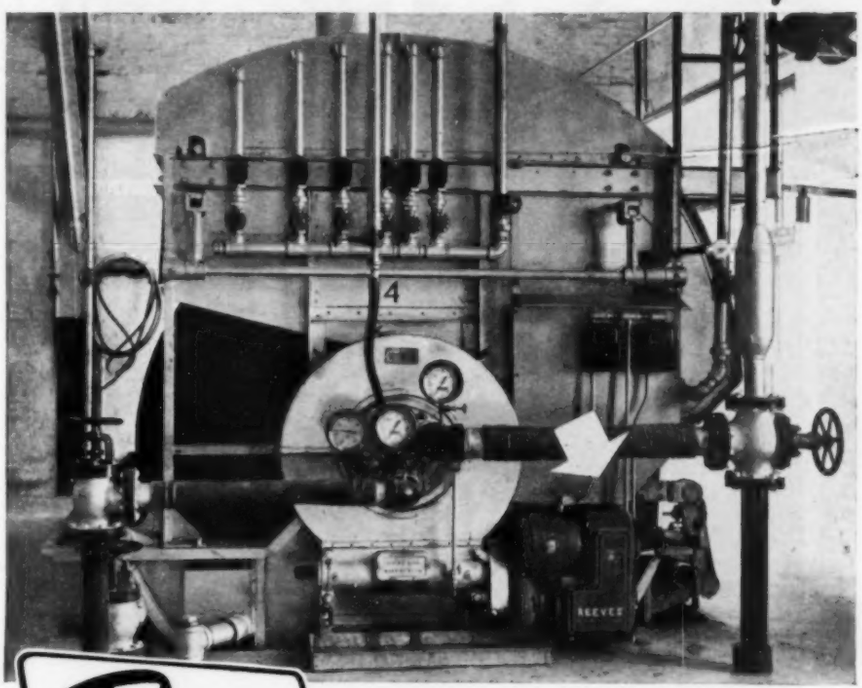

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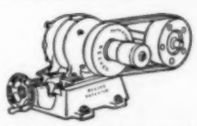

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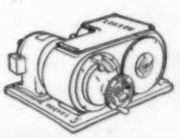

MOTODRIVE—combines motor, variable speed drive and gear reducer (if needed). To 10 h.p.; speed range 2:1 through 6:1.

● Morse Automatic Vacuum Filters—shown above in operation in a large sugar beet factory—are equipped with an agitator which oscillates at a predetermined speed. The REEVES Motodrive with which these filters are equipped permits this oscillating speed to be changed at any time to meet different filtering and dewatering problems. Speed changes are quickly and accurately made without stopping operation of filter. This is but one of many types of processing machines on which REEVES Variable Speed Control is helping to give dependably uniform performance and increased output at lowest cost per unit of material handled. REEVES variable speed units are standardly supplied on 1440 different makes of machines—and are easily and inexpensively applied to machines in service. Catalog-Manual CMG-419 will be sent on request.

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Accurate Variable **REEVES SPEED CONTROL**

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materials and the simplicity of the processing required, it is expected that the product can be made more cheaply per unit of P_2O_5 than other phosphatic fertilizers. The magnesium content of the product should prove advantageous for many fertilizer applications.

J. H. Walthall and G. L. Bridger, Tennessee Valley Authority, Wilson Dam, Ala., before the American Chemical Society, Buffalo, N. Y., Sept. 7-11, 1942.

PREPARATION OF SULPHONATED PEANUT OIL

WORK WAS INITIATED in 1940 by the Georgia State Experiment Station to discover why more peanut oil did not find an outlet as a raw material for sulphonation. Only 13 tons were sulphonated during the quarter ending March, 1940.

Laboratory experiments show that peanut oil is relatively easy to sulphonate. Agents employed were sulphuric acid, fuming sulphuric acid and chlorosulphonic acid. By careful sulphonation, washing and neutralization a soluble oil can be produced.

Sulphonated peanut oil shows a tendency to cloud on standing due to the separation of saturated fatty acids. Some users of sulphonated oils consider this a disadvantage, but others do not. A more serious problem is that of the formation of odors either in storage or after application to textiles. The problem of odors during storage may be met by use of a well-defined deodorized oil. The development of odors after application to textiles is serious, but work of promise is being done on inhibitors to meet this particular problem.

Of particular interest was the behavior of an oil prepared from peanut oil that had been fractionated by use of solvents and cooling. This process removed a larger amount of saturated fatty acids and the product produced by sulphonation showed no tendency to cloud or separate on standing. Mixtures of peanut and other oils were sulphonated; 25 percent castor and 75 percent peanut oil gave an excellent product.

Sulphonated peanut oil is an excellent softener for textiles and gives a "soft hand". It may be used in shampoos, as a pine oil emulsifier, and in many other mixtures where a sulphonated oil is demanded.

J. B. Gallent, Georgia State Experiment Station, Experiment, Ga. before the American Chemical Society, Memphis, Tenn., April 20-24, 1942.

SOUTHWESTERN CHEMURGIC PROGRESS

MOST STRIKING progress in chemurgic activities in the southwest is being made in the field of substitute vegetable oils for those which no longer can be imported from Asia and other continents. These oils may serve as food or as rapid drying oils, aromatic and essential oils, medicinals or insecticides.

It is estimated that there is a total of about 2,000,000 tung trees now growing in Louisiana and Texas, most of

them planted in the last few years: 5,000 acres of castor beans in various parts of Texas and Oklahoma; 100,000 acres of soybeans in Louisiana, Texas and Oklahoma; 25,000 acres of winter flax along the Texas gulf coast; 5,000 acres of safflower in Texas, New Mexico and Oklahoma; and a record acreage of 5,000,000 acres of Spanish peanuts throughout the entire southwest.

At Brownsville a castor oil extracting mill has been set up, after two years of difficulty, which is to crush the crops of beans maturing in south Texas at present. Last season, castor beans were raised on some 1,700 acres in Texas, but rainy weather failed to permit the plants to yield more than around 350 lb. of beans per acre. In dry seasons, yields of 1,200 lb. have been obtained under test.

One of the expanding industries of the Pineywoods areas is that of steam and destructive distillation of longleaf and slash pine stumps. Up to perhaps 10 or 15 years these pine stumps become more valuable because the sun and air bring about chemical changes within the stumps, concentrating materials such as rosin, turpentine and pine oil. In all the Gulf States there are nearly 50,000,000 tons of pine stumps, the U. S. Forest Service survey shows. The Naval Stores industry today is experiencing a boom, as drying oils, varnishes, and other chemicals are produced from 30 shredding and processing plants now in operation.

At Laurel, Miss. is the plant where, under government supervision, white sweet potatoes are made into starch with a stock feed as byproduct. At St. Francisville, La., there is a sweet potato stock feed plant which showed a good profit last year, processing mostly white yams. At Denton, Tex., near Dallas, is the Gilbert C. Wilson Laboratory, where sweet potatoes of the Puerto Rico variety are dehydrated. The plant has a capacity of 10 tons of yams a day.

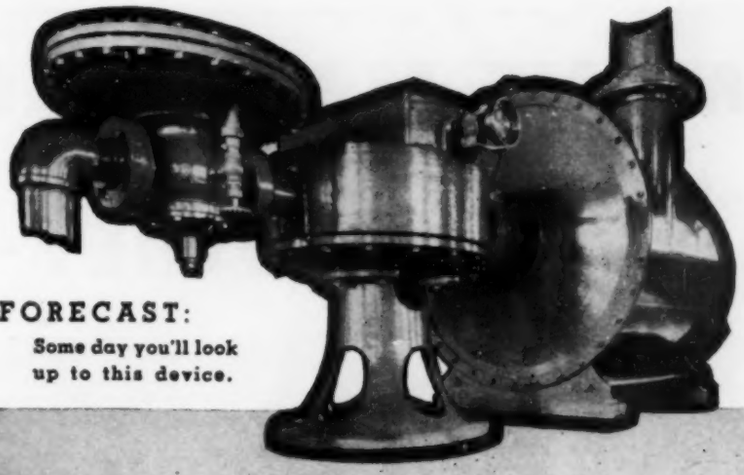
The South's first pine newsprint paper mill at Lufkin in East Texas has been in successful operation for two years and is now doubling its capacity from 50,000 tons of newsprint to 100,000 tons a year, at an investment of $3,000,000 or a grand total outlay of $9,000,000.

Recent crops of Dalmatian sage in North Texas have sold for $1,200 a ton, and were grown at the rate of 700 lb. of dried sage per acre. Sage seed has jumped from $5 to $150 per lb. The Southwest is also growing spice crops other than sage, such as paprika, cayenne peppers, lavender, anise and other rare herbs formerly imported.

Victor Schoffelmayer, Agriculture-Science Editor, The Dallas News, Dallas, Tex., at the 8th annual Chemurgic Conference, Chicago, Ill., March 26, 1942.

COTTONSEED MEAL IN PHENOLIC PLASTICS

COTTONSEED MEAL, a product of high protein content obtained from cottonseed oil mills, has been used as a cattle feed exclusively so far but may



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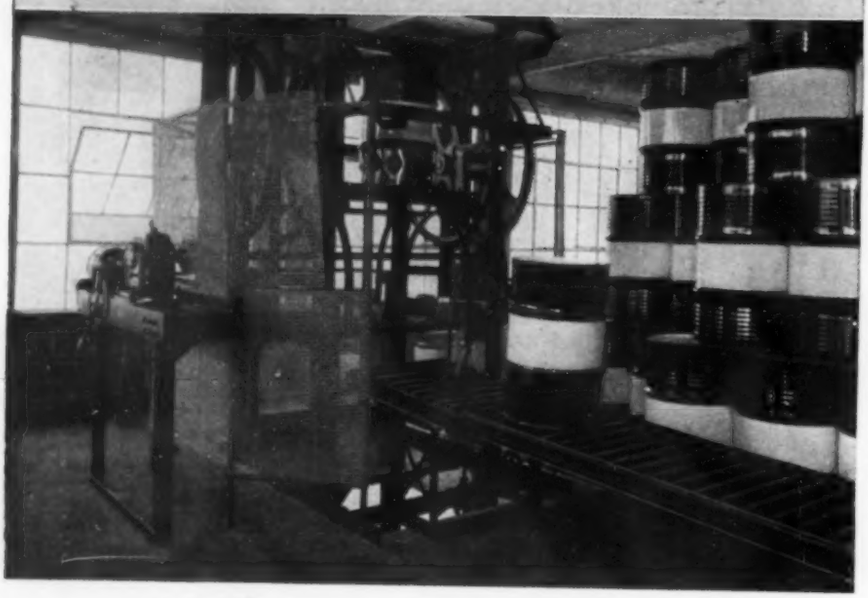

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find an industrial application in the manufacture of phenolic molding powders. While cottonseed protein is very similar to soybean protein, it cannot be taken for granted that the results obtained with soybean meal would be applicable to cottonseed meal. Practically all cottonseed meal has been subjected to a cooking process preceding and facilitating the recovery of cottonseed oil, contrary to soybean meal, which is available uncooked. It has been generally assumed that this cooking process severely damages the protein of cottonseed meal. Hence no research has been devoted to its industrial utilization.

A molding compound consisting of equal parts of phenolic resin, cottonseed hulls, and cottonseed meal, was developed at the Cotton Oil Laboratory of the Tennessee Agricultural Experiment Station. The economic advantage of such a compound lies in the fact that its raw material cost is 20 percent below that of a commercial phenolic molding powder. Results obtained are in close agreement with those obtained with soybean plastics. Hence, it is proved that the cooking of cottonseed meal should not be an impediment for its incorporation in plastic molding powders.

Fritz Rosenthal, University of Tennessee Agricultural Experiment Station, before the American Chemical Society, Memphis, Tenn., April 20–24, 1942.

AMERICAN TUNG OIL

THE FIRST successful tung plantings in this country were made in 1906, but for many years progress was slow. In 1930 the U. S. Census of Agriculture showed a total of 350,793 tung trees and the Census of 1940 gives the total trees planted as of April 1940, as 12,671,344. This is an increase of 35-fold in ten years. The distribution of plantings shown by this Census was: Mississippi, 74.8 percent; Louisiana, 13.9 percent; Florida, 9.6 percent; Alabama, 0.8 percent; Georgia, 0.6 percent and Texas, 0.3 percent. Plantings as of April 1942 should approximate 250,000 acres.

America has imported as much as 175,000,000 lb. of tung oil from China in a single year, and the U. S. Department of Commerce has stated that our normal annual domestic consumption of tung oil amounts to 150,000,000 lb. However, total imports for 1941 approximated only 33,000,000 lb., a little more than one-fifth of our normal requirements. The 1941 domestic crop of tung nuts should yield about 5,000,000 lb. of oil.

As long ago as last summer, the government appreciated the necessity of conserving stocks of tung oil, and it was placed on the list of critical materials by a priorities regulation issued August 27, 1941. Early in December, dealers' stocks of oil were frozen and only defense orders carrying priority ratings A-1 to A-10 could be filled. On January 8, 1942, the Office of Production Management issued a general preference order M-57 to cover tung oil. This order stated that

the Defense Supplies Corp. would buy all existing stocks. Orders having A-2 ratings could be filled as well as those for manufacture of can linings for human foods and for outside can coatings when essential for food processing and when health, sanitary or safety regulations specifically require tung oil.

Research chemists are just beginning to realize the potentialities of the tung tree. There are indications of many interesting medicinal and chemical properties and preliminary studies have been made of the leaves, green nuts, pomace and hulls. All of these show promise. Some authorities claim that the meal may come to have a value greater than the oil.

It has been estimated that the tung belt contains only about 736,000 acres of land suitable for growing the tree, so at present approximately 30 percent of all this suitable acreage is planted. Very few of these plantings have attained maturity, nor were all of them so well planned and managed that they will produce maximum crops.

W. M. Smith, Jr., Technical Advisor, Reasor Tung Plantations, Inc., Chicago, Ill., before the 8th annual Chemurgic Conference, Chicago, Ill., March 27, 1942.

PHOSPHATIC FERTILIZER AND IRON FROM FERROPHOSPHORUS

FERROPHOSPHORUS is a byproduct of the reduction of rock phosphate by the electric furnace method. A process has recently been developed for the conversion of ferrophosphorus into a phosphatic slag useful as a fertilizer and iron of high purity. The process consists of (1) heating a mixture of finely ground ferrophosphorus and finely ground limestone in a rotary kiln to obtain a partial oxidations of ferrophosphorus and complete calcination of the limestone, and (2) melting the resultant kiln product in an electric furnace to obtain phosphatic slag and iron.

When ferrophosphorus containing 20 percent phosphorus and 8 percent silicon was used, the phosphatic slag contained about 22 percent P_2O_5, of which 95 percent was soluble in citrated ammonium nitrate solution. The iron contained 0.2 percent phosphorus and other impurities in similar proportions. The conditions required for operation of the process were determined in small-scale experiments and checked on a pilot plant scale. Plant growth tests with two soils indicated that the phosphatic slag was the equal of concentrated superphosphate as a source of phosphorus for plants.

G. L. Bridger and R. M. Neel, Tennessee Valley Authority, Wilson Dam, Ala., before the American Chemical Society, Buffalo, N. Y., Sept. 7-11, 1942.

STATUS OF INSECTICIDES AND FUNGICIDES

ALTHOUGH ARSENIC is one of the basic materials for insecticides, formerly nearly one-half of the arsenic used in this country was imported from Sweden, Belgium and Japan. Last September the arsenic situation looked cri-

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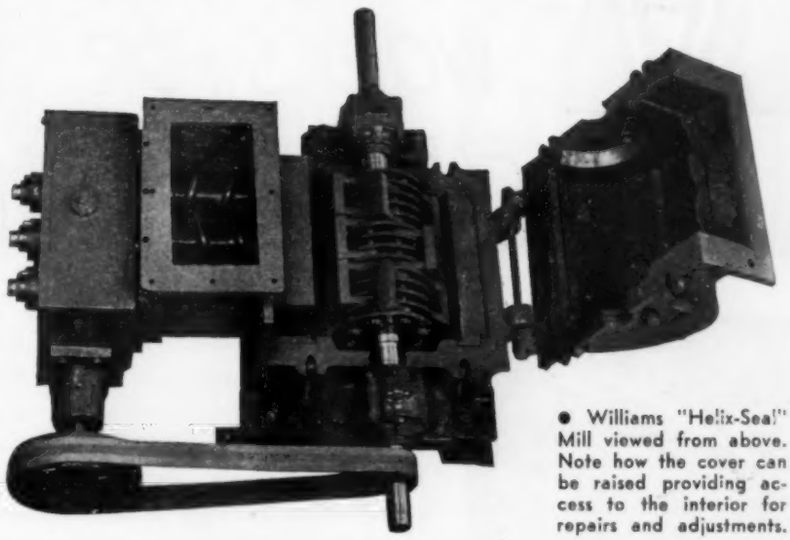

● Williams "Helix-Seal" Mill viewed from above. Note how the cover can be raised providing access to the interior for repairs and adjustments.

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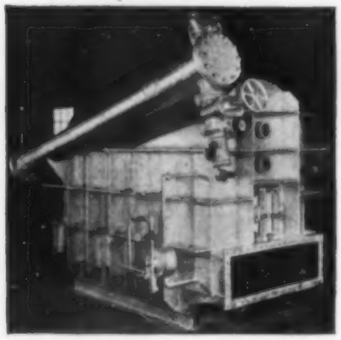

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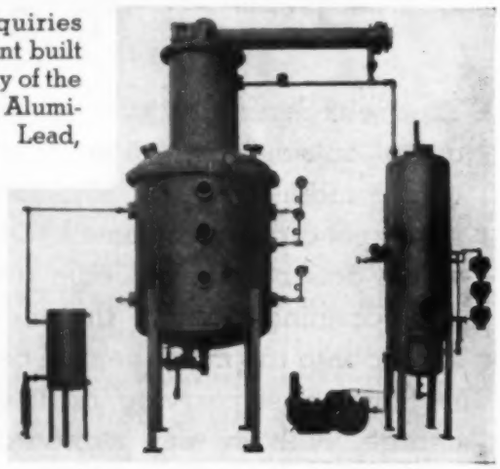

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tical. The stock-piles at the smelters had been used up and users became dependent upon day-to-day production. Depletion of the reserves was attributed to the tremendous insecticide demand and increased consumption in unexpected places.

The War Department withdrew a considerable amount as a stock-pile for manufacture of poison gas for the Chemical Warfare Division. Millions of yards of khaki cloth required for uniforms, blankets, etc., call for arsenic acid, the principal ingredient in making the khaki dye. The glass industry began consuming more arsenic because of shortages of other more favorable ingredients. Arsenical weed killers found a larger market because of the shortage of chlorates used for the same purpose. The State Department encouraged export of arsenicals to South America to solidify our position with those countries which had been buying considerable quantities of insecticides from Japan, Germany and other countries. All these factors created a temporary shortage, putting the manufacturers of insecticides behind in their production schedule, so that this season is going to see a rather tight situation. The insecticide industries contributed by restricting the use of arsenicals as much as possible to customers who need it most.

Rotenone is another item that will be increasingly short. During the calendar year of 1941, 8½ million lb. of rotenone, on the basis of 5 percent root, was imported to this country. Roughly 60 percent came from the Far East, from Java, Singapore and Manila. South America produced about 40 percent of the rotenone requirements and this can be increased possibly another 20 percent. Fortunately, this year a large percentage of the season's requirement had already been imported. Next year the situation will be critical.

Practically all of the pyrethrum supplies for this country came from the Kenya Province of British East Africa. As far back as last summer, it was reliably calculated that the 1942 supply of pyrethrum had already been arranged for and imported to this country. Considerably more pyrethrum can be produced in Kenya, but it is a matter of available ship-bottoms to bring it over. The commercial use of pyrethrum will very likely show considerable increase if the sealanes from Kenya can be kept open.

There are several new organic insecticides produced from plants grown in Jamaica, Mexico and domestically. While they may not be as good as rotenone, pyrethrum or nicotine, they can be substituted in large volume in certain specialized spraying. In addition, there are several inorganic materials which show promise or are already accepted as having proved effectiveness. Some of these synthetics can be used alone. Others serve to increase the effectiveness of rotenone.

James R. Hile, Insecticide Department, Acme White Lead & Color Works, Detroit, Mich., at the 8th annual Chemurgic Conference, Chicago, Ill., March 27, 1942.

MAKING ACTIVATED CHARCOAL FOR GAS MASKS

WHEN THE Germans decided to introduce chemical warfare during World War I, they had some knowledge of the properties of activated charcoal. Their first activated charcoal was made by soaking blocks of ordinary wood in $ZnCl_2$, carbonizing in contact with a small amount of air and heating the charcoal to a relatively high temperature out of contact with air to distill out the $ZnCl_2$.

Another process, developed by an Austrian, involved producing ordinary charcoal in granular form, treating with steam and air under conditions approximating those used in the water-gas reaction. The residue had a much greater absorptive power for gases than other types of charcoal. In the United States the steam and air activation process was used exclusively during World War I. It was found that coconut shells, cohune nutshells, black walnut shells, peach pits, apricot seeds and some high quality, semi-anthracite coal could be used as raw materials.

Gradually, due to the availability of coconut shells and the difficulty of producing charcoal from other sources, these shells became the only raw material used in the United States. Almost all of the coconut shells had to be imported.

About 1928 the problem of producing charcoal from domestic raw materials was undertaken in earnest in this country. It was shown that activated charcoal suitable for use in gas masks must be able to absorb its own weight of gas from air containing a high concentration of the gas at ordinary temperatures. In order to keep the size of the canister reasonable, it was decided that an apparent density of ordinary granules of at least 0.4 that of water should be obtained. A satisfactory charcoal would have to be hard and tough enough to resist shattering.

There are now three methods by which this hard, dense, highly activated charcoal can be obtained: the briquetting process, carbonizing under pressure, and the zinc chloride process.

High quality coal can be reduced to low-temperature coke and then treated with air just below the ignition temperature. This gives a partial activation. Ordinary hard wood charcoal and the low-temperature oxidized cokes are ground to pass a 200-mesh screen, mixed with high-melting pitch, heated in the dry powder state and forced through extrusion dies by means of a suitable press. The extruded material, in the form of spaghetti-like strings, is passed through low-temperature carbonizing, high-temperature carbonizing, air activation and steam activation steps to produce a fine grade of gas mask charcoal. While this process involves numerous steps, the raw materials are available in unlimited quantities at comparatively low prices.

In many areas, especially the Pacific Northwest and the South, there are enormous quantities of sawdust that

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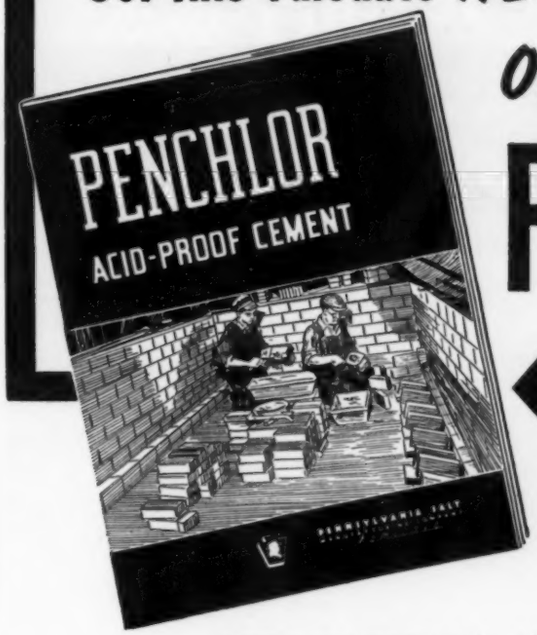

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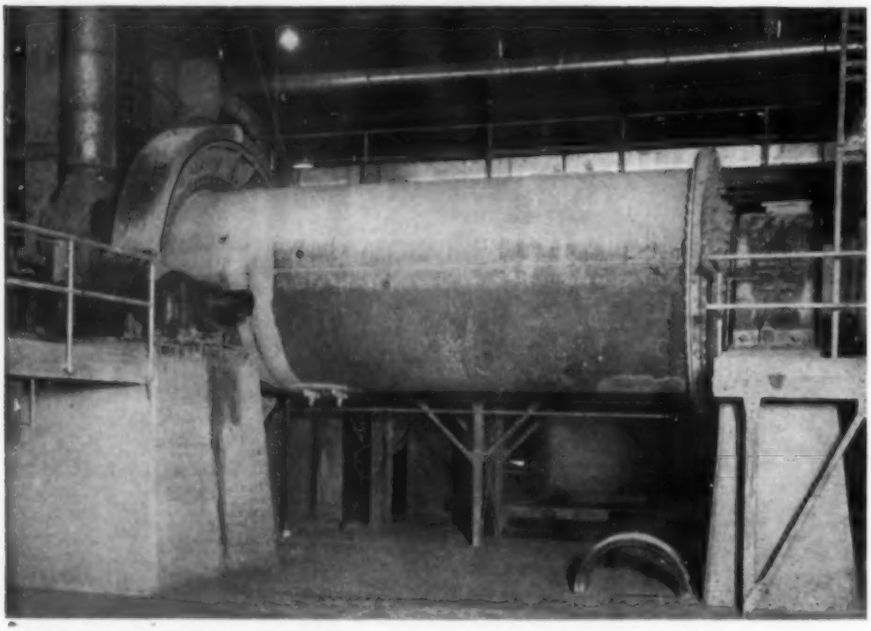

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can be run through a suitable hammermill and compressed into logs. These can be carbonized under pressure to produce a charcoal having the density of ordinary coal and the ease of activation of wood charcoal. Once the logs are formed and converted into dense charcoal, the procedure for converting this into activated carbon is essentially the same as in activating the briquetted material.

In view of the success of the Germans in making activated charcoal by the $ZnCl_2$ method, it was natural that this country should also develop the process on a production basis to make a product equal in quality to that produced by the other two methods.

Just a few months ago, coconut shells were regarded as one of the most important strategic materials which we would have to import from the East Indies in large quantities. However, due to the developments just described, this country is now able to make charcoal of excellent quality at a reasonable price from a variety of domestic raw materials available in unlimited quantities.

Maurice E. Barker, Chemical Warfare Service, U. S. Army, at the College of William and Mary, Williamsburg, Va., Feb. 4, 1942.

IRON REMOVAL FROM WATER BY CARBONACEOUS ION EXCHANGERS

IT REQUIRES LESS than 1.0 p.p.m. of iron present in water to stain household bathroom fixtures and kitchen sinks. The modern municipal water treatment plant aims therefore to reduce the iron present in the supply to the consumers to a concentration of 0.1-0.2 p.p.m.

The Zeolite method of water softening has long been recognized as the satisfactory method of domestic water softening. A series of tests made with carbonaceous exchangers revealed that these had considerable ability for the removal of iron by means of physical adsorption. Other tests disclosed that the adsorbed iron could be released from the carbonaceous exchanger by regeneration by either sodium chloride, calcium chloride or magnesium chloride. Common salt proved to be the most effective regenerant.

In the removal of iron from pure solutions, the capacity of the exchanger for iron removal is as great as it is for hardness removal. Concentrations of 50 p.p.m. are removed as readily as those of 5 p.p.m. In treating public water supplies the presence of the hardness-forming constituents, calcium and magnesium, as well as the concentration of iron present in solution influences the results obtained from a capacity viewpoint.

The carbonaceous type of "zeolite" will also remove iron and hardness simultaneously from public water supplies. In the domestic field, a small water softener filled with this type of product offers a complete solution to this recognized problem. If hardness removal is not demanded, each cu.ft. of exchanger housed in a properly designed tank will deliver as much as

4,000 gal. of iron-free water in treating a supply having an initial iron content of 5 p.p.m.

F. K. Lindsay, National Aluminate Corp., Chicago, Ill., before the American Chemical Society, Memphis, Tenn., April 20-24, 1942.

CHEMICAL ENGINEERING ASPECTS OF MATERIALS OF CONSTRUCTION FOR CENTRIFUGAL FANS

AVAILABLE DATA on chemical engineering aspects of fan design and maintenance are few and of a general nature. There is a definite need for such data and as productions are increased and as shortages of materials of construction develop, this need will become more evident.

When the chemical engineer handles non-corrosive or non-erosive gases, his problem is no different from that of the ventilating engineer. However, when corrosive or erosive gases are handled, the chemical engineer has to add maintenance and repairs to his economic balance. These frequently become the most important item. Materials such as stainless steel, lead at low temperature, aluminum, ceramics, etc., have properties which allow their direct use in place of steel. Others such as rubber, lacquers, baked coatings, and lead at elevated temperatures, must have a support of stronger material. In general, the latter group gives the most trouble in practice and therefore it is preferable, wherever possible, to use homogeneous materials rather than coated steel.

Most difficulties center around the centrifugal force exerted in the fan. Since the size of fan for a given service usually varies as the allowable speed at which it can operate, the effort to produce fans of lower capital cost often is halted by increased repair and maintenance resulting from the higher speeds. The attack on this problem of lowering capital costs without increasing repairs can take two forms: (1) resistance of the material to stresses can be increased, or (2) the fan can be designed to decreased stresses or, what is usually synonymous, centrifugal forces.

Coated Steel Impellers—A good coating should be impervious to the corroding material and should have sufficient adhesive strength so that it is not pulled off by stresses caused by operation of the fan. Frequently the application of material as several layers or the burnishing of the surface will solve the first problem. In other instances it can be shown that the layer was originally impervious, but excessive erosion by materials in the gases caused failure. Where failure is due to a poor bond, the only solution is usually to try other methods of bonding. In some cases the technique of the man doing the work is highly important. With some materials it is possible to drill the steel support and fill the holes with the coating material so that a good part of the surface is not a bond but is homogeneous.

The case of a fan in chamber H_2SO_4

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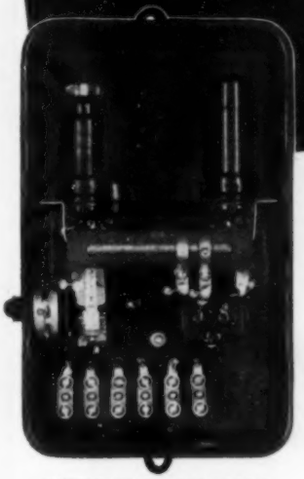

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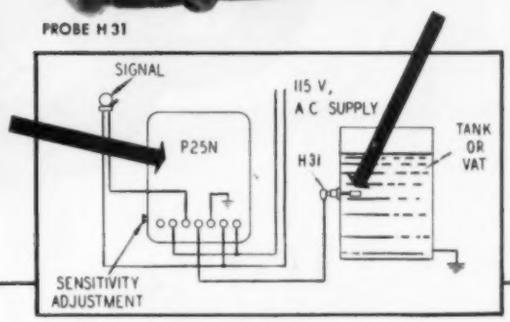

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Better Pumping Practice
SINCE 1894

service can be cited. A lead-covered steel fan had given poor service. After a few months of operation, failure had taken place and large pieces of lead were being stripped from the steel base by centrifugal action. Examination indicated that corrosion of the steel was lifting the lead so that centrifugal forces were overcoming the strength of the bond and were peeling the lead off the steel base. The base was drilled with numerous small holes and the lead was applied so as to fill both the holes and to get a good surface bond with the steel. Failure still occurred but stripping of lead from the steel ceased. It was then shown that cracking of the lead at the hub allowed corrosion to take place on the steel. Since any shaft tends to bend slightly due to the weight on it and is under alternate compression and tension, it was decided that cold working was the cause of the cracking. The shaft was made larger and stronger. This stopped the failure at the shaft and gave increased life. Failure was then encountered at the point on the blades just opposite the wall of the inlet flue. An examination indicated that excess erosion was taking place. This was traced to the action of large particles of acid which travelled along the walls of the inlet flue and were whipped off across the blade. This acid was eliminated and increased life was again obtained. The next failure occurred at the tip and was traced to erosion by acid spray carried in the gas. Building up the lead on the tip increased the life still more.

Instead of attempting to improve the design, it is sometimes possible to do as well by changing materials of construction in such a way as to sacrifice corrosion resistance but to improve the physical properties. In one case where a gas saturated with water vapor and containing SO_2 and H_2SO_4 mists was being handled at about 195 deg. F., the coating material was successively sprayed with lead, homogenized lead, soft rubber, hard rubber and neoprene. Impeller life was increased from a month to well over a year.

It is well to examine the change in design which is necessary when changing the material of construction. The case of a multi-blade fan operating at 200 deg. F. on wet gases containing a small amount of dust can be cited. The impeller, which was made of glyptal resin-coated steel, failed after one year due to corrosion. It was decided to go to a stainless steel impeller, even though initial cost was higher. The next failure occurred after six months. Corrosion was negligible, but in attempting to keep the cost low, the blades had been made of lighter gage material and dust in the gas which formed a coating on the impeller now caused unbalance and strain. Mechanical failure resulted.

Homogeneous Impellers—When using non-standard material for impeller construction, it is well to consider physical properties of the material and their relation to stresses which will be encountered. Principal

stresses in a fan impeller are the radial and hoop stresses due to centrifugal force and the normal stresses near the shaft due to torque and bending action. The former are likely to result in failure due to creep and exceeding the tensile strength.

Published properties frequently differ from those at operating conditions. A case in point is the use of antimony lead versus chemical lead. At ordinary temperatures the first is to be preferred, but at temperatures greater than 120 deg. C. soft lead would be preferable.

Carl V. Herrman, chemical engineer, E. I. du Pont de Nemours & Co., Wilmington, Del., before the American Institute of Chemical Engineers, Boston, Mass., May 11-13, 1942.

• • •

Inherent Hazards of Industrial Chemicals

Material	Fire	Explosion	Dermatitis	Burns	Toxicity	
					Short	Long
Acetone	x	x	x			
Aluminum dust	x	x				
Ammonium perchlorate		x				
Amyl acetate	x					
Amyl alcohol (A)	x					
Anhydrous ammonia			x		x	
Aniline					x	
Barium chlorate	x	x				
Barium peroxide	x	x				
Benzine	x	x	x			
Benzol (benzene)	x	x	x			**x
Bleaching powder			x			
Bromine	x				x	
Bronze dust	x	x				
Butane	x	x				
Cadmium						x
Camphene	x					
Carbolic acid	x		x	x		
Carbon bisulphide	x	x			x	
Carbon tetrachloride			x			x
Chlorinated lime			x			x
Chlorine					x	
Chlorodiphenyls			x			x
Chloronaphthalene			x			x
Cyclopropane	x	x				
Dichlorethyl ether						x
Didymium nitrate	x					
Dixon	x	x	x			x
Ethyl alcohol	x		x			
Ethylene	x	x				
Ethylene dichloride						x
Formaldehyde			x			
Formic acid	x		x	x		
Fulminate of mercury		x	x			x
Fulminate of silver		x				
Gasoline	x	x	x			
Hydrochloric acid				x		
Hydrocyanic acid	x	x	x		*x	
Hydrogen fluoride			x	x		x
Hydrogen sulphide					*x	
Lead						x
Magnesium	x	x				
Mercury			x			x
Methanol			x			x
Nitraniline	x				x	
Nitric acid	x	x		x		x
Nitrobenzene						x
Nitrochlorobenzene		x				
Nitrogen oxides					*x	
Phosphorus (red)	x	x	x	x		x
Phosphorus(W or Y)	x	x		x		
Picric acid	x	x				x
Potassium	x			x		
Potassium chlorate		x				
Potassium cyanide			x		x	
Potassium hydroxide			x	x		
Potassium nitrate	x					
Potassium permanganate		x				
Potassium peroxide		x				
Silver nitrate				x		
Sodium	x			x		
Sodium cyanide			x		x	
Sodium hydroxide			x	x		
Sodium peroxide		x				
Sulphur	x	x				
Sulphuric acid	x			x		
Tetrachlorethane						x
Tetrachlorethylene						x
Thorium nitrate	x					
Toluol (toluene)	x					x
Trichlorethylene			x			
Turpentine	x		x			
Vinyl ether	x	x				
Xylol (xylene)	x					x
Zinc chlorate		x				

* Fatal in exposures of short duration to very small quantities.
** Tolerance to benzol fumes is extremely low.
From *Occupational Hazards*, March, 1942.

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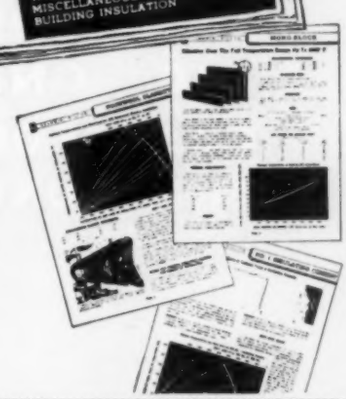

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Parts subject to erosive action are made of stoneware (Tip T and Disc D) therefore there is comparatively little or no wear. Last almost indefinitely in sulphur gases and they will not break or crack from temperature changes. Bodies and caps are made of hard lead.

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The Fig. 645 nozzle has many applications—for scrubbers, air washers, washing acid phosphate and other gases. Furnished in cast brass, cast iron, Everdur it withstands chemical reaction and wear in acid gases better than nozzles of softer screw machine brass. Made for either "solid" or "hollow" cone spray.

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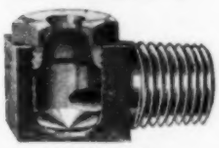

Fig. 629

For use wherever there is any likelihood of clogging due to impurities in the liquids sprayed. Produce a hollow cone spray. Furnished standard in Brass, and Stainless Steel and also of Hard Rubber (known as Fig. B-27).

INDUSTRIAL OIL BURNER NOZZLES

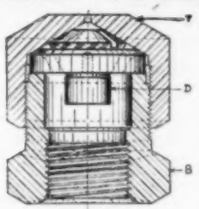

Fig. D-41

This industrial oil nozzle is made entirely of steel, the tip and disc being hardened to resist erosive action at high pressures. Using No. 6 fuel oil heated to 250 degrees F. operating pressures range from 200 to 300 lbs., and capacities to 600 G.P.H.

HUMIDIFYING AND OIL BURNER NOZZLES

Fig. F-80

For Humidifying: Made of brass in capacities from .57 gph up on water. For Oil Burners: Made of stainless steel in capacities from .60 G.P.H. up @ 100 lbs. No. 2 oil.

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SELECTIONS FROM FOREIGN LITERATURE

DIESEL FUEL ACCELERATORS

COMPREHENSIVE tests of Diesel fuel ignition accelerators showed that various compounds are powerful accelerators. Among them are alkyl nitrates, alkyl nitrites, alkyl peroxides, halogen nitrates, nitroso compounds and polysulphides. For example, 2 percent of ethyl nitrite raised the cetane number of a lignite tar distillate from 39 to 58. A cetane number of 50 is the specification standard for satisfactory Diesel fuel performance. The effect is lasting; all the effective accelerators were still fully effective 6 months after they were added to the oil. But there are two serious limitations on the utility of Diesel fuel accelerators. One is their tendency to intensify the corrosion activity of the fuel. The other is their adverse effect on the coking properties of the fuel. These are properties which should be tested in every candidate material.

Digest from "Utility of Diesel Fuel Ignition Accelerators," by Heinze, Marder and Veidt, *Chemiker-Zeitung* **65**, 149, 1941. (Published in Germany.)

SELENIUM PHOTOELECTRIC CELLS

SMOOTH non-porous films of gray selenium are essential in photoelectric cells of the selenium type. An effective film on iron or bronze plates is obtained by vacuum sublimination under controlled temperature conditions. The temperature at the metal surface must be such that the photosensitive form of Se is deposited. The anterior electrode is formed by cathode sputtering from selected metals under controlled conditions of pressure, atmosphere and current. The best electrode results from depositing an infinitesimal film of cadmium in an atmosphere of nitrogen, then depositing gold over it. At low external resistances the photocurrent in such a cell is proportional to the intensity of light and is about 570 microamperes per lumen. The maximum photosensitivity at a constant energy level is at 6,000 A units. Some types of selenium cell have very high rectifier values, sometimes over 1,000.

Digest from "Selenium Photoelectric Cells: Construction and Characteristics," by G. Berraz and E. Virasoro, *Anales de la asociacion quimica argentina* **30**, 51-2, 1942. (Published in Argentina.)

ALCOHOL IN GASOLINE

BLENDS of gasoline and absolute alcohol, as used for motor fuel, cannot be tested accurately by the Reid vapor pressure method. The reason is that the standard method calls for rinsing the air chamber with water before use. Even the small amount of water left after rinsing is a serious source of error and may even cause phase separation in gasoline: alcohol blends. The presence of water tends to make the apparent vapor pressure lower than the actual value. Thus, a blended motor fuel may show only 8 in the standard test when its actual vapor pressure is 10. It would then be tested against gasoline with vapor pressure 8. The comparison would indicate an increase in the tendency of the fuel toward vapor lock, whereas a test against gasoline with vapor pressure 10 would have shown a decreased tendency toward vapor lock. Thus the error due to water in the air chamber may reverse the rating of a blended motor fuel. The error is avoided by a slight modification of the standard test, i.e. by drying the air chamber before use (rinsing with alcohol or acetone and blowing with air). Obviously the water displacement method cannot be employed for taking the sample; the gasoline chamber is filled from a siphon.

Digest from "Reid Vapor Pressure of Alcohol Blends," by S. J. W. Pleeth, *Journal of the Institute of Petroleum* **28**, 113-4, 1942. (Published in England.)

COMMERCIAL GRAPE MARC ASH

THE ASH from raw grape marc is exceptionally rich in potash, yielding 12 percent or more of water-soluble potassium compounds (calculated as the oxide). Spent marc from distillery operations is much poorer in potash; its ash yields only 2.5 percent of available potassium oxide. Hence the ash from spent marc, unlike the ash from raw marc, is not a profitable source of potash salts. It is, however, an excellent fertilizer. For this purpose it has the special merit of returning to the soil three essential elements (lime, phosphorus and potash). This ash, though relatively low in potash content, is rich in phosphates (5.7 percent calculated as P_2O_5) and lime (22.7 percent calculated as CaO). Hence it is excellent for renewing the fertility of lime-impoverished soils.

Digest from "Commercial Grape Marc Ash," by Luis E. Marchese, *Anales de la asociacion quimica argentina* **30**, 49-50, 1942. (Published in Argentina.)

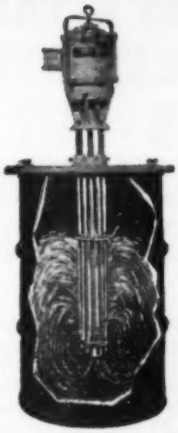
VISCOSITY OF SOLVENT BLENDS

THE SIX possible binary pairs from the four solvents benzene, toluene, chlorobenzene and cyclohexane have been studied in a Höppler precision viscometer. Measurements were made at 10, 20, 30, 40 and 50 deg. C., with the viscometer enclosed in a Höppler thermostat. Proportions of the binary blends were varied 10 mol percent at

Viscosities for benzene and cyclohexane, temperature in deg. C. and viscosity in poises X10

Pure Benzene		*50 mol % each*		*Pure Cyclohexane*	
t	*V*	*t*	*V*	*t*	*V*
12.9	0.7509	13.7	0.7635	13.5	1.1326
21.2	0.6559	19.6	0.6982	19.6	1.0122
31.7	0.5927	30.4	0.6035	30.6	0.8403
39.8	0.5173	39.5	0.5397	39.6	0.7277
49.6	0.4749	50.3	0.4785	...	.....

S-T-R-E-T-C-H Man Hours



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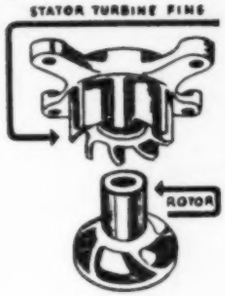

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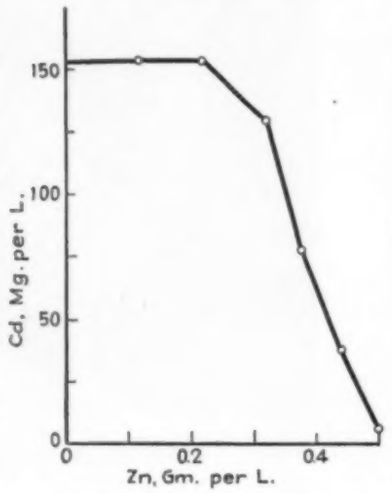
a time. The results show that the logarithm of viscosity in the binary blends is a linear function of the logarithms of viscosity of the pure solvents. As an example, the viscosities for benezene and cyclohexane are shown in the table, where t is deg. C. and V is viscosity in poises x 100.

Digest from "Viscosity of Binary Liquid Mixtures," by R. Linke, *Zeitschrift für physikalische Chemie* **188A** 17-26, 1942. (Published in Germany.)

FREEING ZINC FROM COPPER AND CADMIUM

ZINC dust can be effectively used for removing copper and cadmium from zinc by applying the treatment to the normal thickener overflow during the hydrometallurgy of zinc. To remove cadmium the initial pH must be 3.5 or



Influence of zinc dust on cadmium removal

higher. Agitation must be adequate, but not so vigorous as to cause aeration. The time factor must be controlled within narrow limits. Cadmium redissolves if the treatment is prolonged. Apparently the reason for this is electrolytic corrosion, analogous to underwater rusting of iron in the neutral zone. Copper does not redissolve in the same way under the conditions employed for its precipitation so that the only essential attention to the time factor in this case is to control the minimum. The influence of amount of zinc dust on cadmium removal is illustrated by plotting cadmium concentration (after 45 minutes of agitation) against quantity of added zinc dust.

Digest from "Removal of Copper and Cadmium in the Hydrometallurgy of Zinc," by G. T. E. Graham and T. Thorvaldson, *Canadian Journal of Research* **20B**, 93-102, 1942. (Published in Canada.)

FAT FROM THE SEASHORE

A HARD waxy fat which is found in lumps at a depth of a few centimeters along the shore near Parnaiba in Piaui, Brazil, is apparently derived from algæ or from some low form of plant life. It is brown in color and has a strong penetrating odor. It is insoluble in water but soluble in the usual fat solvents; its density is 0.95. For a fat

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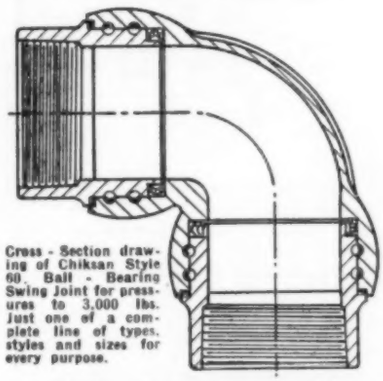

Cross - Section drawing of Chiksan Style 60 Ball - Bearing Swing Joint for pressures to 3,000 lbs. Just one of a complete line of types, styles and sizes for every purpose.

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its melting point is high (58-61°C.) but chemically it is a fat, not a wax, and it has a high free fatty acid content. This crude fat contains about 0.28% moisture, 0.8% ash, 0.14% sulphur and 0.07% nitrogen. It has no drying properties; its iodine number is only about 30. Industrially, the fat could be utilized in soap manufacture since it contains only about 0.5% unsaponifiable matter. It should be noted, however, that its soap is hard and only sparingly soluble in water. Its possibilities for use in other ways depend on its composition; analysis indicates that it is particularly rich in palmitic and myristic acids.

Digest from "A Seashore Fat From Piauí," by Camilla Rolin, *Revista de quimica industrial* **11**, No. 118, 13-5, 1942. (Published in Brazil.)

INDUSTRIAL SPECTROSCOPY

Among the many industrial applications of spectroscopic analysis there are some, e.g. in analyzing metals and alloys, for which the spectroscope is not merely the simplest and best means but the only means of detecting impurities. Metallurgists now produce such pure zinc that the spectroscope is needed to disclose trace elements therein, unless such large samples are used that analytical costs would be prohibitive, and so much reagent would be needed that its own impurities would make the analysis uncertain. Turning from emission to absorption, assays of provitamin D and vitamin A by absorption spectroscopy are now saving much time and expense as compared with chemical and biological assays. Two current problems in analysis may also be mentioned which can probably be solved by spectroscopic methods. Both are important industrially. One is the determination of potassium and magnesium in the commercial production of potash salts from potash brines. The other is differentiation of pure olive oil from its blends and from adulterated oils by a rapid, convenient and reliable test. Here again one problem is for emission and the other for absorption spectroscopy.

Digest from "Industrial Spectroscopic Analysis," by J. Barcelo, *Ion* **1**, No. 2, 24-7, 1941. (Published in Spain.)

POTASH FOR SUGAR BEETS

A common blight of sugar beets has been shown by growth tests to be caused solely by potash deficiency. Often the soil selected for beets is poor in potash and needs a properly proportioned fertilizer. A hectare of such soil should receive the equivalent of at least 0.45 metric ton of 80 percent KCl for sugar beet culture. High sugar content demands good leaf growth and with proper care beets with 17.04 percent sugar have been raised on well fertilized soil. In one growth test series the ash of beets raised without fertilizer ranged from 4.58 to 10.13 percent in K_2O content whereas soil enriched with a potash fertilizer grew beets the ash of which contained from 28.42 to

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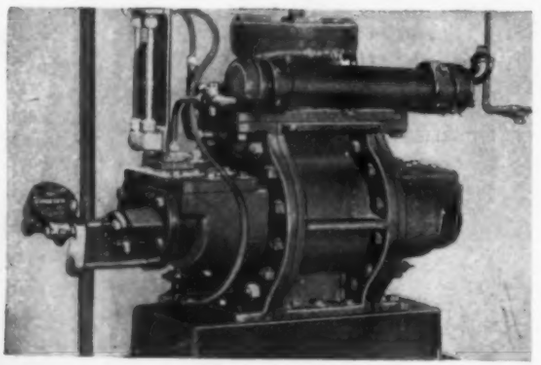

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72.01 percent K_2O. In general, if no accurate soil analysis is available, it is advisable to choose the chloride in selecting a potash fertilizer. For soil of known composition the fertilizer is selected and proportioned according to the analysis.

Digest from "Potash Salts, Controlling Factor in the Normal Growth of Sugar Beets," by F. Blasco Lopez-Rubio, *Ion* **1**, No. 4, 15-22, 1941. (Published in Spain.)

DENATURING ALCOHOL

IT HAS been found that the process developed by Michot and Dupont for cracking vegetable oils can be adapted to production of an excellent denaturant. The operation is carried out in such a way as to yield a combustible gas and 55-60 percent of a dark oil with a characteristic empyreumatic odor. Fractional extraction of this oil yields a combustible fraction and another fraction which is such a potent denaturant that 0.1 percent renders alcohol completely unfit for beverage use. The outstanding feature of this denaturant is that alcohol containing it cannot be rendered potable by any of the known physical or chemical methods which are effective with other denaturants. Distillation yields a distillate which still has the characteristic empyreumatic odor of the denatured alcohol. The same is true when the alcohol is diluted with water before distillation.

Digest from "New Denaturant for Alcohol," by Anibal R. Mattos, *Revista brasileira de quimica* **13**, 92-3, 1942. (Published in Brazil.)

STABILITY OF GAS BURNER FLAMES

THE DEAD space between a gas burner head and the base of the flame is so closely related to the flareback tendency of the flame that the relation can be utilized in controlling flareback. Dead space can be estimated by measuring the limiting burner diameter for flame propagation. These diameters have been determined for several simple combustible gases and for some commercial fuel gases. Chemical composition is an influential factor; small additions of ethylene to coal gas cause relatively large changes in limiting burner diameter. Debenzolizing a city gas supply also has important effects on the flareback tendency.

Since blowoff is another factor which influences flames stability the blowoff limit was also determined for each of several simple gases and for city gas supplies. Tests with split, double cone and non-aerated flames showed that the type of flame also has its effect on the blowoff limit. These experiments clearly demonstrated that there is no essential relation between flareback and blowoff. Hence in testing burner flames for stability behavior it is necessary to study the two phenomena separately.

Digest from "Stability of Aerated Burner Flames," by J. E. Garside, A. R. Hall and D. T. A. Townend, *Institution of Gas Engineers Communication* No. 245, 1-32, 1941. (Published in England.)

New Titles, Editions and Authors

CHEM & MET BOOKSHELF

SOLVENT RECOVERY

THE RECOVERY OF VAPORS. By *Clark Shrove Robinson.* Published by Reinhold Publishing Corp., New York, N. Y. 273 pages. Price $4.75.

A DEFINITE need for this book has existed for several years. Some 20 years ago the author published an earlier volume on the same subject, but this has long been out of print, and only the periodical literature, advertising bulletins, and occasional chapters in other books have been available to chemical engineers in the United States. Meanwhile, in the years since the appearance of the first book, most of its contents has become obsolete so far as actual practice is concerned, and nearly all of the science of vapor condensation by adsorption with active solid adsorbents has come into being.

The author's exposition is simple and rational. Much of what he says is easily comprehensible to the average intelligent non-engineer reader, although by no means too elementary for the engineer just getting into the subject. The earlier chapters review the physical and chemical principles involved, so that readers who need to brush up will not have to turn to other books for the purpose. Two obviously necessary related subjects, however, have been almost entirely omitted, namely, vaporization of the solvent from the material with which it has been used, and the subsequent separation of the solvent from other materials by fractional distillation. As the author points out, these subjects are both already fully covered in the literature and both in fact require extensive separate treatment.

If the book leaves something to be desired in its format and typography, still, its purpose has been well achieved. The reader will emerge with a good fundamental grasp of the principles involved, the methods and the equipment used, and the types of recoveries being effected by the various means elucidated. Furthermore, the author has achieved one end that is too frequently overlooked in engineering texts: he has handled his subject so interestingly that the book is hard to lay down, once its reading has been started.

PETROLEUM TECHNOLOGY

CHEMICAL REFINING OF PETROLEUM. Second Edition. By *Vladimir A. Kolichevsky* and *Bert Allen Stagner.* Published by Reinhold Publishing Corp., New York, N. Y., 550 pages. Price $7.50.

SEVEN years is a long time in measuring the advance of petroleum technology, so it is only natural that the 1942 edition of this volume of the American Chemical Society Monograph Series should be almost completely revised and rewritten from the first edition of 1934. The immediate object of the present volume, of course, was to bring up-to-date the "bewildering array of chemical refining and treating processes" used in the chemical treatment of petroleum and its products.

Chemical composition of crude oil and the effects of this on the distillation products are discussed in the opening chapter. Then follows a very complete explanation of sulphuric acid treatments, disposal and utilization of acid sludge and hydrogen sulphide, and various commercial methods for the recovery and manufacture of sulphuric acid.

Additional sections of the text deal with the subjects of treatment with alkaline reagents, sweetening operations and sulphur elimination, refining by adsorption, refining by solvents, detonation and antidetonants, oxidation inhibitors, gums, cracked petroleum products and deterioration of lubricating and similar oils. Some 78 pages are devoted to an impressive supplementary list of U. S. patents on petroleum refining, classified according to major treating processes and beginning with a patent granted in 1854. The patent, author, and subject indexes, all separate, are unusually complete. Bibliographies at the end of the various chapters are extensive and well selected. Petroleum technologists, chemical engineers, chemists and others who wish to keep informed on advances in the chemical refining of petroleum should not hesitate to add this volume to their working bookshelves.

PRINCIPLES OF HEAT TRANSMISSION

INTRODUCTION TO HEAT TRANSFER. By *Aubrey I. Brown* and *Salvatore M. Marco.* Published by McGraw-Hill Book Co., New York, N. Y. 232 pages. Price $2.50.

ALTHOUGH this book was written by mechanical engineers, primarily *for* mechanical engineers, chemical engineers will find it a valuable link between their "Principles of Chemical Engineering" and the more advanced texts on heat transfer. The style is easy, the mathematics not too advanced for those who are a little rusty, and the content at the same time is quite comprehensive.

The authors have had as their main aim the establishment of a thorough ground work in the principles of actual heat transfer. Wisely, little effort has been expended in attempting to correlate the frequently divergent work of the many investigators in the field, but instead the authors have attempted to select and include the best available data with which to substantiate the theory. To insure facility in the use of the material, they have included many worked-out examples. An important phase of the book is the care with which the principles of dimensional analysis have been presented as they apply to heat transfer. A grasp of this subject greatly facilitates the correlation of experimental results and clarifies the relations between variables, showing how one changes when others are modified.

The approach employed is, in general, not unusual, progressing by easy stages through conduction, radiation and convection, to vaporization and condensation as means of heat transfer. One chapter deals with simultaneous transfer by several mechanisms. One of the most useful portions of the book is an excellent section on the handling of a variety of design problems. A considerable although by no means exhaustive data section is also included.

TECHNOCRACY'S 1942 MODEL

THE COMING SHOWDOWN. By *Carl Dreher.* Published by Little, Brown & Co., Boston, Mass. 419 pages. Price $3.

Reviewed by *S. D. Kirkpatrick*

Two years ago an article in *Harper's Magazine* entitled "Why Hitler Wins" attracted considerable attention. This reviewer commented then on the fact that an engineer had taken the German war machine apart and had found that science and technology were what made it tick. The author has since described himself as a successful radio engineer who had been born in Vienna, Austria, in 1896, had been graduated from C.C.N.Y. in 1917 and had retired to writing after his 20 years in industry had made him "perhaps one of the few hundred best paid engineers or engineering executives in the country." So much for his background. He is no Howard Scott—nor yet a Thorstein Veblen. But just as his earlier writings smacked a bit of Technocracy, so does the present book preach a dismal and discouraging philosophy of American business and industry.

Engineer Dreher would have us take a leaf from Germany's book and somehow harness our vaster technical powers and resources to carry us, not to destruction, but to some idealistic state he defines as "democratic collectivism." To get there means complete overhauling of our business machine through a veritable revolution that would bring engineers and technologists to the leading roles of industrial administration. Applying this thinking to the present national crisis, he would have our war effort directed by an economic general staff like Goering's, made up not of

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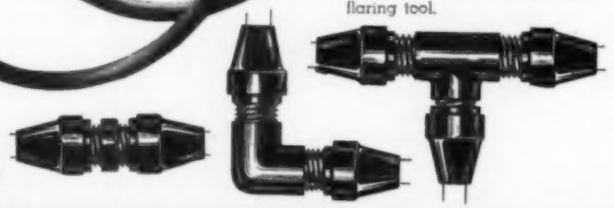

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army economists and business men, but of "management engineers, adaptable industrialists, labor economists, surviving New Dealers, and professors who know whither the world is going." They would have been delegated executive power over all production, transportation, investment of capital—in short, the whole economic life of the United States. That, he feels, is about the best way to prevent an American Dunkirk.

Frankly, there is much of this 400-page book that this reviewer has not read nor does he intend to read it later. The comprehensive index helped him to discover the chapter on "Business-Patriots" where, with something a little short of libel, the author proceeds to pay his respects to Eugene Grace, Pierre S. duPont, Daniel Guggenheim, and Col. Edward A. Deeds—for their contributions in 1917-18. But a little later on in the book these gentlemen find their 1942 counterparts in such names as Edward R. Stettinius, Tom Girdler, Charles R. Hook, Gano Dunn, and Edward R. Weidlein. The section on nitrogen in the chapter headed "Production Performance" is a clumsy, inaccurate, sarcastic attempt to pin the blame for a threatened nitrogen shortage on "the manufacturers of commercial fertilizer, including such needy companies as Allied Chemical, American Cyanamid and duPont."

In presenting Mr. Dreher's work to its prospective readers, the publishers say "His book invites attack. Tear it apart, break it down. What can't be torn apart will furnish solid material on which to build." This is probably a true and conservative statement. The author is better informed technically than the average business-baiter or the wild-eyed technocrats of the early thirties. But his biassed viewpoint and destructive philosophy do no credit to the engineering profession.

STRATEGIC MATERIALS AND NATIONAL STRENGTH. By *Harry N. Holmes.* Published by The MacMillan Co., New York, N. Y. 106 pages. Price $1.75.

THE PRESIDENT of the American Chemical Society presents for popular consumption the stories behind present-day shortages of metals, chemicals and raw materials. *Chem. & Met.* readers are already familiar with most of the difficulties discussed. However, the book presents an over-all picture which may clarify the thinking of those who have an opportunity to read its hundred pages.

GENERAL CHEMISTRY FOR COLLEGES. Third edition. By *B. S. Hopkins.* Published by D. C. Heath & Co., Boston, Mass. 758 pages. Price $3.80.

SUITABLE for college courses in first year chemistry, Professor Hopkins' book follows the usual textbook style and order of presentation of chemical fundamentals. Production and industrial uses of chemicals and metals are

stressed wherever possible. Each chapter concludes with a number of problems and exercises for student consumption are scattered throughout the text.

HANDBOOK OF SCIENTIFIC AND TECHNICAL SOCIETIES AND INSTITUTIONS OF THE UNITED STATES AND CANADA. Fourth Edition. By *Callie Hull, M. Paddock, S. J. Cook* and *P. A. Howard*. Published by the National Research Council, Washington, D. C. 389 pages. Price $4.

DATA on more than 1,400 societies and similar organizations in the natural sciences and related fields are included in this revision. Information given under each listing usually consists of names and terms of president and secretary, a history of the organization, object, membership, dues, meetings, and special features such as library facilities, research funds, medals, and publications. Of the total, 143 are in the Canadian section, and 339 are societies not listed in the previous edition.

RECENT BOOKS and PAMPHLETS

Data Book. Published by The Permutit Co., New York, N. Y. 47 pages. Gratis. A data book on water treatment. Consists of 87 charts and tables of conversion factors, equations and other data for the rapid solution of water-conditioning problems.

PRP, How the New Priority System Works. Prepared by the Research Institute of America, New York, N. Y. 72 pages. Price $2. An analysis of the revised Production Requirements Plan made in an effort to assist in making adjustments necessary under the new business-government relationship.

Explanation of Principles for Determination of Costs Under Government Contracts. Obtainable from Superintendent of Documents, Washington, D. C. Price 10 cents. Outline of the manufacturing and other contract cost items, and expenses of an administrative nature which are allowable under contracts with the Army, Navy, or Procurement Division of the Treasury Department.

Table of Common Hazardous Chemicals, Sixth edition. Published by National Fire Protection Association, Boston, Mass. Price 20 cents. Flammable limits, explosive range, ignition temperature, propagation of flame, flash point, extinguishing methods, shipping containers, storage safeguards, fire and life hazards.

Animal and Vegetable Fats and Oils. Obtainable from Superintendent of Documents, Washington, D. C. 29 pages. Price 10 cents. Production, consumption, imports, exports, stocks. Recorded quarterly for the calendar years 1937 to 1941.

Tools of Victory for the Battle of Production. Published by the Public Library, Detroit, Mich. 100 pages. Price 50 cents. Listings of technical books and industrial training materials. Includes headings of civilian defense, and metals and war substitutes but not chemical engineering.

Bibliography of Some Achievements in Chemistry, 1930-1941. By *Lloyd McKinley*. Bulletin 11, University of Wichita, Wichita, Kan. 60 pages. Price 15 cents. A list of references to articles in the technical press. Grouped alphabetically by author's name in one of 48 sections—Abrasives, Absolute Zero, Adhesives, etc.

Engineering Index. 57th edition. Published by Engineering Index, Inc., New York, N. Y. Price $50. The 1941 edition of the Index contains 26,000 annotations of important articles and 40,-

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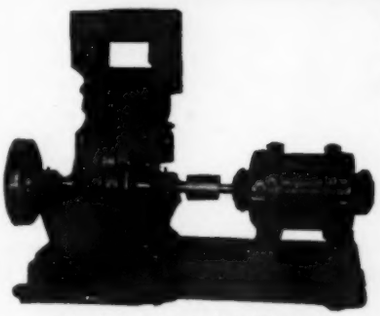

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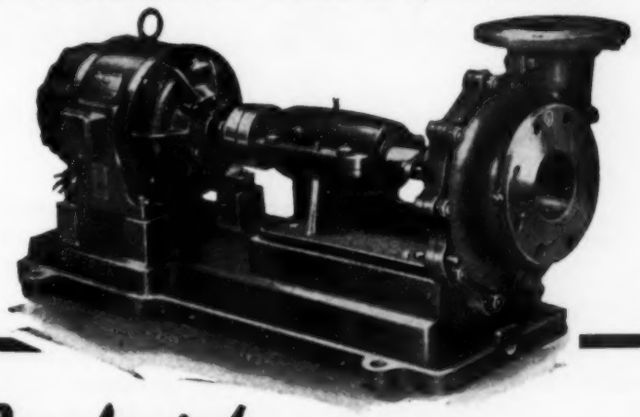

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000 cross-references to these annotations. All important technical articles are included.

Industrial Chemistry as an Occupation. Published by Occupational Index, Inc., New York University. 6 pages. Price 25 cents. One of a series giving work, requirements, income, etc. in various occupations.

Sound Measurement Test Code for Centrifugal and Axial Fans. Bulletin 104 of National Association of Fan Manufacturers, Detroit, Mich. 6 pages. Price 10 cents. Establishes a commonly used method of sound determination for designers and users of fans.

Vitamins for Health. By *H. Borsook* and *W. Huse.* Pamphlet 69, Public Affairs Committee, New York, N. Y. 32 pages. Price 10 cents. A guide to the knowledge of vitamins for everyday use.

Standard Methods for Testing of Welds. Published by American Welding Society, New York, N. Y. 25 pages. Price 40 cents. Describes principal mechanical tests applied to welded joints and weld metal: density, soundness, tensile strength, shearing strength and ductility.

Definitions of Welding Terms. Published by American Welding Society, New York, N. Y. 32 pages. Price 40 cents. Standard definitions of terms adopted by the American Welding Society. Booklet includes a chart showing various subdivisions of the principal welding processes.

Social Security. Published by Industrial Relations Institute, New York, N. Y. 32 pages. Price 15 cents. (Less in quantity orders.) Prepared for employers distribution to workers. Intended as a morale builder, the booklet enables the employee to familiarize himself with details of his combination of life insurance, annuity, and unemployment insurance under the Social Security program. Impresses on them that the employer contributes 4 percent of their salaries in the form of old-age and unemployment insurance.

Depreciation of Group Properties. By *Robley Winfrey.* Iowa State Engineering Experiment Station Bulletin 155, Iowa State College, Ames, Iowa. 131 pages. Gratis. Depreciation is an item of cost which should be known exactly because of new income tax legislation. This booklet gives the results of a study of methods of calculating depreciation of group properties. Recommended is the unit-summation procedure of the present-worth method. Bulletin 156 (price $3) contains depreciation tables for 18 types of life curves.

Strength and Properties of Materials. By *John Elberfeld.* Published by Harper & Brothers, New York, N. Y. 150 pages. Price $1.75. A textbook for refresher and short courses. Contains definitions of terms and formulas used in strength calculations. There are also descriptive chapters on production, properties, testing and uses of common metals, alloys, concrete, and plastics. Elementary.

Elementary Structural Analysis and Design. By *L. E. Grinter.* Published by The Macmillan Co., New York, N. Y. 383 pages. Price $3.75. Textbook for the structures courses which are required of all engineering students. Steel is given primary importance, but modern timber and reinforced concrete construction receive thorough discussion. Treatment is simple yet complete enough for those who are not to be required to design skyscrapers.

The Effect of Range of Stress on the Fatigue Strength of Metals. By *James O. Smith.* Bulletin No. 334. Published by the University of Illinois, Urbana, Ill. 49 pages. Price 55 cents. An analysis of previously published test data for both ductile and brittle metals.

Sponge Chromium. By *C. G. Maier.* Bulletin 436, U. S. Bureau of Mines. Available from Superintendent of Documents, Washington, D. C. 109 pages. Price 20 cents. Gives theory of gaseous reduction of oxide chromium, gas reduction of oxides from features of chloride metallurgy for chromium and study of chlorination of chromite ores.

Intercrystalline Cracking of Boiler Steel and its Prevention. By *W. C. Schroeder* and *A. A. Berk.* Bulletin 443. U. S. Bureau of Mines. Available from Superintendent of Documents, Washington, D. C. 85 pages. Price 15

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cents. A summary of results obtained from an investigation started in 1933. In three parts: (1) Intercrystalline cracks, (2) Development and Testing of Embrittlement Detector, (3) Protection from intercrystalline cracks.

Testing in Modern Industry. Published by United States Testing Co., Hoboken, N. J. 105 pages. Price 50 cents. An illustrated booklet describing the services U. S. Testing Co. is equipped to render. These concern the textile industries primarily. A number of pages of tables of data are included.

Conservation of Vital War Transportation. Published by Office of Defense Transportation, Division of Local Transport, Washington, D. C. 35 pages. This booklet is directed to the problem of conserving automobile tires. It describes a proposed organization to put into effect a community plan. A second part deals with staggered working hours, and a third part is devoted to plans for promoting group riding among fellow employees of industrial plants.

Saving Fourdrinier Wires. Prepared by J. E. Goodwillie. Published by Technical Association of the Pulp and Paper Industry, New York, N. Y. 21 pages. No. 2 of the TAPPI monograph series. Specific instructions and suggestions for the pulp and paper industry.

Bibliography of References to the Literature on the Minor Elements. Third Supplement to the Third Edition. Compiled by *L. G. Willis.* Published by Chilean Nitrate Educational Bureau. Abstracts are concerned with the minor elements and their relation to plant and animal nutrition. This supplement covers material which has been published since April 1941.

Engineering Essentials for Welders. By *H. M. Priest.* Published by the American Welding Society, New York, N. Y. 24 pages. Price 25 cents. Contains practical information for designers, welding operators and welding students.

Recommended Practices for Inspection of Fusion Welding. Published by American Welding Society, New York, N. Y. 23 pages. Price 40 cents. Discusses qualifications and duties of welding inspectors, inspection and testing of welded structures, welding characteristics of both ferrous and nonferrous metals. There is also a brief section on etching reagents.

Proceedings. Chemical Engineering Division, Forty-Eighth Annual Meeting, Society for the Promotion of Engineering Education. Compiled by the Executive Committee, Chemical Engineering Division, S.P.E.E. Contains reports of committees and papers presented at the meeting held June, 1940, at Berkeley, Calif.

Directory of War Agencies. Chamber of Commerce of the United States has issued and is distributing to industrial inquirers one of its "War Service Bulletins" which is a directory of the many Federal agencies participating in any phase of the war program. Copies of the pamphlet issued under date of June 15 can be had on request without charge from the War Service Division, Chamber of Commerce of the U. S., Washington, D. C.

Opinion of Hon. Francis G. Caffey in United States of America v. Aluminum Company of America et al. Published by the West Publishing Co., Brooklyn, N. Y. 311 pages. Opinion in the longest legal trial in history wherein the corporate life of the Aluminum Co. was thoroughly probed.

Kansas Mineral Resources for Wartime Industries. By *J. M. Jewett* and *W. H. Schoewe.* University of Kansas Publications, Lawrence, Kansas. Fuels, metals, non-metallics and water resources.

Blueprint Reading for the Metal Trades. By *W. A. DeVette* and *D. E. Kellogg.* Published by the Bruce Publishing Co., Milwaukee, Wis. 132 pages. Price $2.50. Textbook.

Industrial Waters of Canada. By *H. A. Leverin.* Bulletin 807, Bureau of Mines, Department of Mines and Resources, Ottawa, Canada. 112 pages. Price 25 cents. A report of investigations, 1934 to 1940. Gives standard methods of analysis, impurities and their effects on industrial processes, chemistry and methods of purification and sampling natural and treated waters. Numerous maps, tables and analyses are included.

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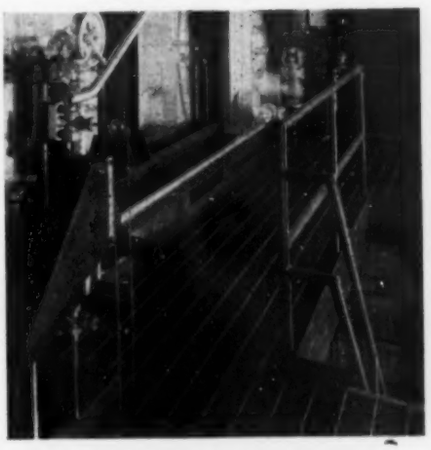

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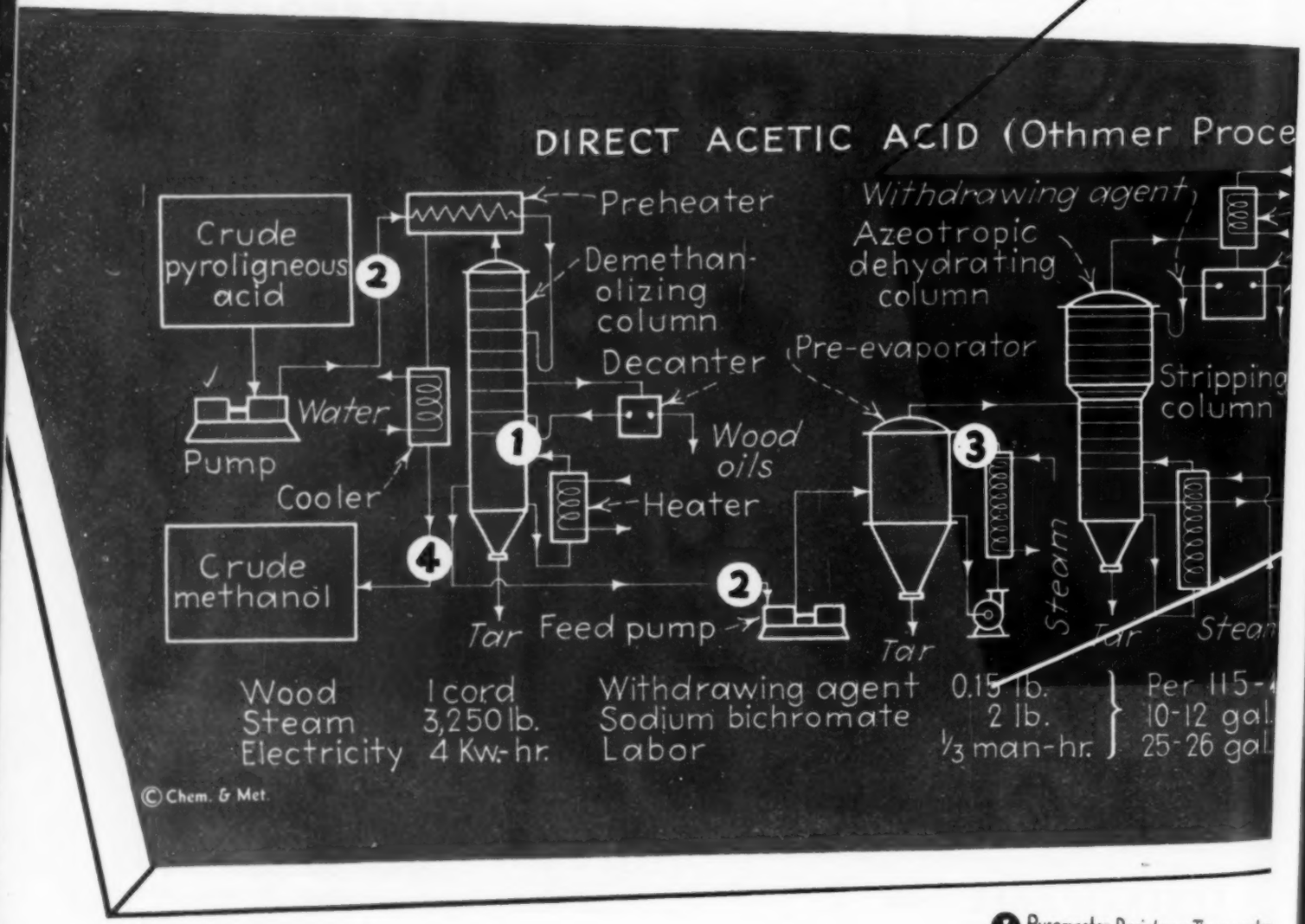

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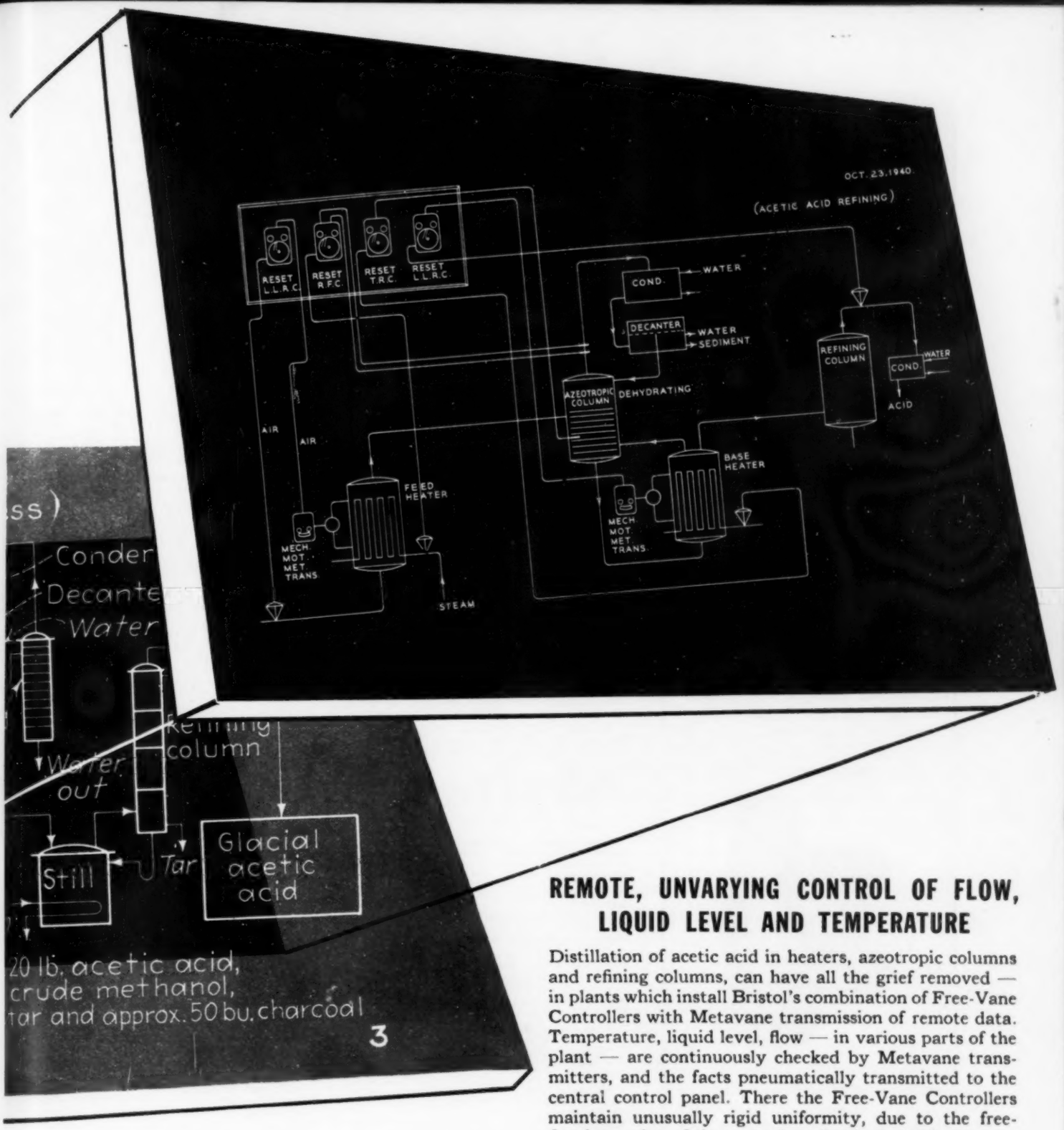
Take out just a few minutes to sketch roughly the flow of your process or processes, and mail to Bristol's Application Engineers. Their suggestions for automatic safeguards of quality and costs are yours without any obligation. Naturally, we also know how to keep a secret.



REMOTE, UNVARYING CONTROL OF FLOW, LIQUID LEVEL AND TEMPERATURE

Distillation of acetic acid in heaters, azeotropic columns and refining columns, can have all the grief removed — in plants which install Bristol's combination of Free-Vane Controllers with Metavane transmission of remote data. Temperature, liquid level, flow — in various parts of the plant — are continuously checked by Metavane transmitters, and the facts pneumatically transmitted to the central control panel. There the Free-Vane Controllers maintain unusually rigid uniformity, due to the free-floating action of the control mechanism, which prevents distortion or delay in indication and correction of any variations. Changes in adjustments are easy to make without dismounting controllers. Plenty of other aids to costs and quality, in acids, heavy chemicals, and *your* industry, are being obtained with the help of Bristol engineers.

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No. 513 on Metavane transmission of remote data . . . No. 4051 on Free-Vane Controllers

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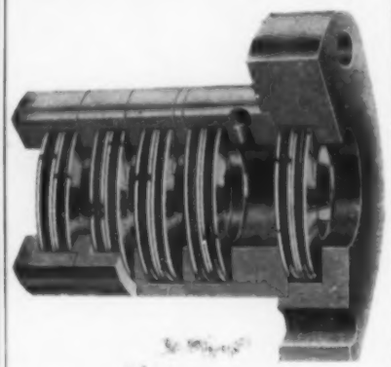

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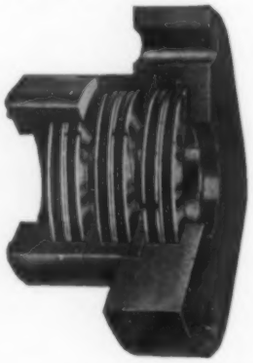

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GOVERNMENT PUBLICATIONS

The following recently issued documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. In ordering publications noted in this list always give complete title and the issuing office. Remittances should be made by postal money order, express order, coupons, or check. Do not send postage stamps. All publications are in paper cover unless otherwise specified. When no price is indicated, pamphlet is free and should be ordered from Bureau responsible for its issue.

Limits of Inflammability and Ignition Temperatures of Nicotine in Air, by G. W. Jones, G. S. Scott, and W. E. Miller. Bureau of Mines, Report of Investigations 3640. Mimeographed.

Magnesium by Electrothermic Reduction, by H. A. Doerner and others. No. 54 of Progress Reports—Metallurgical Division. Bureau of Mines, Report of Investigations 3635. Mimeographed.

Ore-Testing Studies (Precious Metals), by Edmund S. Leaver, Jesse A. Woolf, and A. P. Towne. No. 53 of Progress Reports—Metallurgical Division, Bureau of Mines, Report of Investigations 3629. Mimeographed.

Analyses of West Virginia Coals. Bureau of Mines, Technical Paper 626. Price, 45 cents.

Physical Properties of Cokes From Bureau of Mines—American Gas Association Tests at 800° and 900° C., by D. A. Reynolds and C. R. Holmes. Bureau of Mines, Report of Investigations 3650. Mimeographed.

Dredging Pennsylvania Anthracite, by Joseph A. Corgan. Bureau of Mines, Information Circular 7213. Mimeographed.

Findings From Major Studies of Fatique, by R. R. Sayers. Bureau of Mines, Information Circular 7209. Mimeographed.

Sodium Carbonate, by Charles L. Harness and A. T. Coons. Bureau of Mines, Information Circular 7212. Mimeographed.

Plastic and Swelling Properties of Bituminous Coking Coals, by R. E. Brewer. Bureau of Mines, Bulletin 445. 30 cents.

Bibliography of Bureau of Mines Investigations of Coal and its Products, 1935 to 1940, by A. C. Fieldner. Bureau of Mines, Technical Paper 639. Price, 10 cents.

Instructions for Storing, Handling, and Transporting Explosives. Bureau of Mines, Explosives Control Division. Mimeographed.

Cooperative Manufacture and Distribution of Fertilizer By Small Regional Dry-Mix Plants, by John H. Lister. Farm Credit Administration, Circular No. C-126. Price, 20 cents.

Influence of Variety, Environment, and Fertility Level on the Chemical Composition of Soybean Seed, by J. L. Cartter and T. H. Hopper. Department of Agriculture, Technical Bulletin No. 787. Price, 15 cents.

Toxic and Repellent Sprays for the Control of Elm Bark Beetles, by R. R. Whitten. Bureau of Entomology and Plant Quarantine, Circular 647C. Price, 5 cents.

Static Electricity, by Francis B. Silsbee. Bureau of Standards, Circular C438. Price, 10 cents.

Protection of Radium During Air Raids. Bureau of Standards, Handbook H38. Price, 10 cents.

Corrosion in Soils. Bureau of Standards, Letter Circular LC689. Mimeographed.

Phenolic Disinfectant (Emulsifying Type). Bureau of Standards, Commercial Standard CS70-41. Price, 5 cents.

Phenolic Disinfeetnt (Soluble Type). Bureau of Standards, Commercial Standard CS71-41. Price, 5 cents.

Proceedings of the National Nutrition Conference for Defense. Federal Security Agency. Price, 35 cents.

Discussion of Industrial Accidents and Diseases, 1941 convention of the International Association of Industrial Accident Boards and Commissions, Winnipeg, Manitoba. Labor Standards Division, Bulletin 53. Price, 20 cents.

Analysis of Rigid Frames (An Application of Slope Deflection). Bureau of Yards and Docks. Price, $1.00. This treatise on rigid-frame analysis is a compilation of a series of 44 articles by the author, previously having appeared as technical supplements to the Bureau News Memorandum. These articles were written primarily for the benefit of the Bureau's technical personnel, as an aid in the design of continuous structures. However, the demand in excess of the limited supply of mimeograph reprints has made it necessary to republish the articles in book form.

Cleaning, Preserving, Lubricating, and Welding Materials and Similar Items Issued by the Ordnance Department. War Department, Technical Manual TM 9-850. Price, 20 cents.

Office for Emergency Management Handbook. Office for Emergency Management. This booklet describes the present functions and authorities of the Federal war agencies whose activities are coordinated within the Office for Emergency Management.

Trade Agreement Between the United States and Argentina. Tariff Commission. This document presents digests of trade data with respect to products on which concessions were granted by the United States.

Handbook of Labor Statistics, 1941. Bureau of Labor Statistics, Bulletin 694. Price, Vol. 1, $1.00, Vol. 2, $.45. Vol. 1 gives all topics except wages. Vol. 2 gives wages and wage regulation.

Modern Ship Stowage. Bureau of Foreign and Domestic Commerce. Industrial Series No. 1. Price, $1.50.

Import Restrictions. War Production Board has established a list of about 500 items which may be imported into the United States. No other goods can be allowed to take ship space under these new rulings. The order and list of commodities was published in the Federal Register of July 1. Two supplements to this order have been published, the first one in the July 16 Federal Register and the second one in the Federal Register of July 23. Any further changes in or supplements to the list will be published from time to time in the Federal Register. The Federal Register is available for purchase at 10 cents a copy.

Foreign Commerce and Navigation of the United States for the Calendar Year 1940. Bureau of Foreign and Domestic Commerce. Price, $2.75. This book presents statistics on the import and export trade of the United States by classes of commodities, by countries, and by customs districts, for the year 1940. It includes, also, information on exports and imports of gold and silver; data on drawback paid; number and tonnage of vessels clearing American ports; fishery products; and tariff duties.

Silk and Synthetic Fibers. Bureau of Foreign and Domestic Commerce. Mimeographed.

Changes in Distribution of Manufacturing Wage Earners, 1899-1939. Census Bureau. Price, 30 cents. A cooperative study.

Animal and Vegetable Fats and Oils. Bureau of the Census. Price, 10 cents. This pamphlet gives production, consumption, imports, exports, and stocks quarterly for calendar years 1937 to 1941.

Federal Specifications. The following Federal Specifications have recently been issued and are available from the Superintendent of Documents at 5 cents each: VV-L-791b, Lubricants and Liquid-Fuels; General Specifications (Methods for Sampling and Testing). JJJ-O-348, Oil, Soybean; Refined (For Paint and Varnish). P-S-581, Soap; laundry, chip, rosin-type. P-S-583, Soap; laundry, granulated, rosin-type. P-S-611a, Amendment-1. Soap; salt-water. SS-R-406a, Road and paving-materials; general specifications (methods for sampling and testing). This one specification is available at 10 cents a copy.

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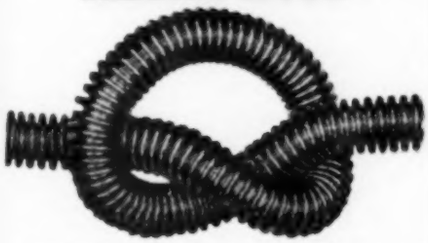

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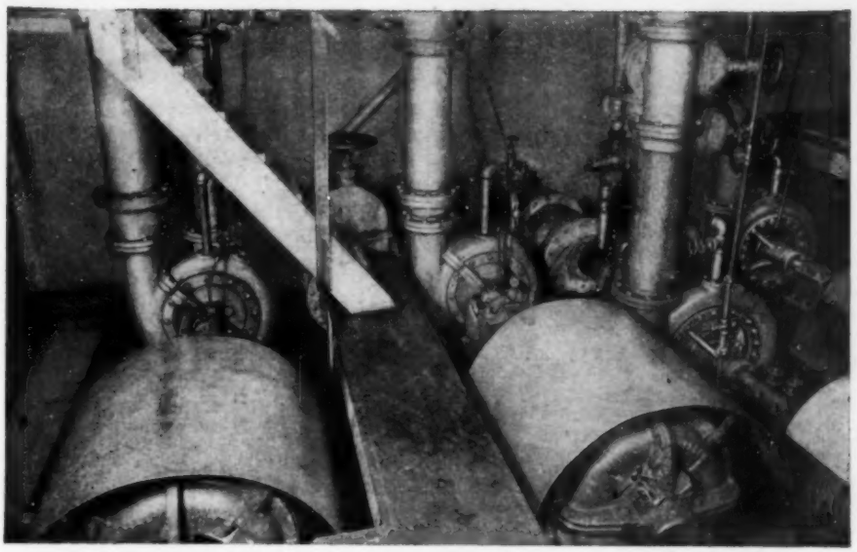

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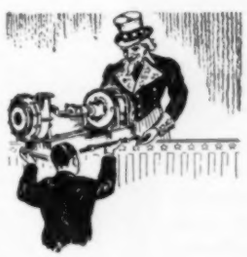

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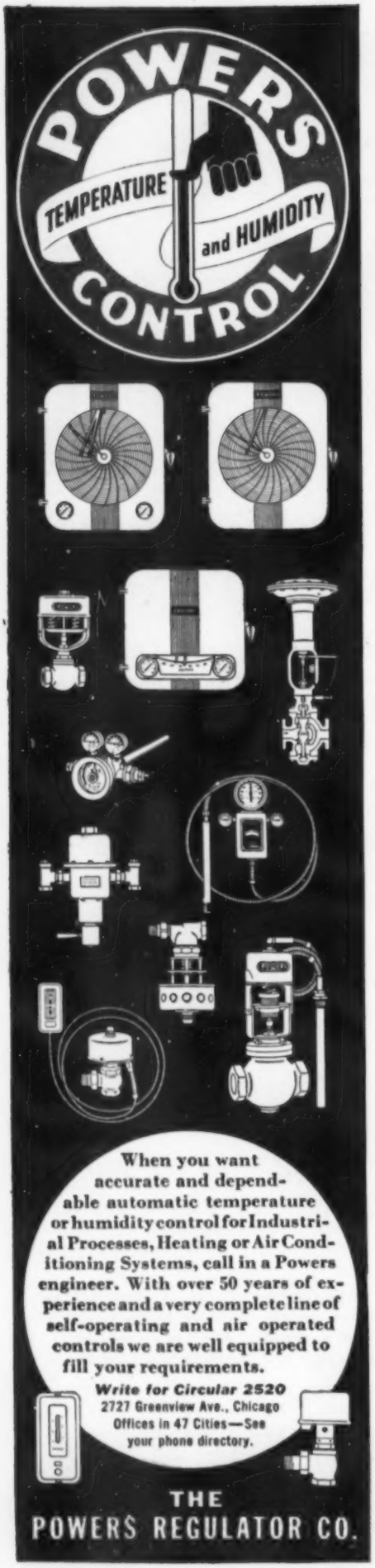
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MANUFACTURERS' LATEST PUBLICATIONS

Publications listed here are available from the manufacturers themselves, without cost unless a price is specifically mentioned. To limit the circulation of their literature to responsible engineers, production men and industrial executives, manufacturers usually specify that requests be made on business letterhead.

Air Conditioning. The Carrier Corp., So. Geddes St., Syracuse, N. Y.—Catalog AC—12-page catalog listing various products of this concern for air conditioning refrigeration and heating. Includes data on specifications, dimensions and applications. Each unit is illustrated.

Air Diffusers. Barber-Colman Co., Rockford, Ill. — Bulletin 30F — 26-page catalog describing and illustrating details of functions and types of this concern's grilles, registers, and overhead air diffusers for air conditioning purposes. Contains numerous cross-sectional and diagrammatic drawings, together with tables of dimensions.

Aluminum Machining. Aluminum Co. of America, Pittsburgh, Pa.—Form AD31B—44-page booklet entitled "Machining Alcoa Aluminum and Its Alloys." Discusses general machining practice, tool materials and shapes, engine lathe practice, reamers and saws, grinding and finishing, etc., as well as automatic screw machine practice, such as drills, threading tools, cutting compounds and box tools. Numerous tables include engineering data on aluminum alloys, mechanical finishing of alloys, physical properties, mechanical properties, comparative weights of standard screw machine stock, etc. Designed to give general principles of machining aluminum and its alloys; to suggest speeds, feeds and depth of cuts for satisfactory results; to point out where common practice as well as tools of standard design may be used; and to indicate where the use of special practices or tools is desirable. Well illustrated.

Belt and Pulley Conservation. Sprout, Waldron & Co., 100 Sherman St., Muncy, Pa.—Bulletin 3001—40-page form which illustrates, describes briefly, and gives case histories of applications of this concern's "belt saver" for prolonging the life of conveyor and elevator belts and pulleys. Includes data on sizes and specifications.

Brush Sifters. Robinson Mfg. Co., Muncy, Pa.—Catalog 27A—8-page catalog dealing with the brush sifters for food, drugs, chemical and allied industries, put out by this concern. Illustrates and describes briefly types of the spiral, straight and other types of sifters. Includes tables of specifications.

Combustion Instruments. The Hays Corporation, 975 Shirl Ave., Michigan City, Ind.—2-page reprint illustrating and describing briefly the line of combustion instruments, such as automatic combustion control, draft gages, portable combustion testing instruments, combustion meters, automatic Orsat, etc., put out by this concern.

Control Instruments. Barber-Colman Co., Rockford, Ill.—36-page condensed catalog on temperature control products for heating, ventilating, air conditioning and industrial applications. Discusses motor-operated valves, control motors, thermostats, humidity controllers, program switches and accessory equipment. Includes data on uses, construction, installation, dimensions, and specifications of each unit, together with illustrations and tables of engineering information. Includes roughing-in dimension drawings.

Control Instruments. Paper and Industrial Appliances, Inc., 122 E. 42nd St., New York, N. Y.—8-page folder dealing with this concern's "Brammer" recording consistency control system for regulation of difficult stocks such as lumpy or stringy rags, dirty wastepaper or free sulphite. Discusses principles, applications, and advantages. Includes diagrammatic drawings.

Copper Conservation. General Electric Co., Schenectady, N. Y.—Bulletin GED1011—20-page folder entitled "Five Ways to Conserve Copper in War Plant Electrical Systems." Describes in non-technical language various methods of copper conservation and amounts that can be saved. Diagrams illustrate conservation by use of high-voltage circuits, locating substations in centers of load areas, use of small size substations, high-temperature insulation, etc.

Drum Handling. Ernst Carrier Sales Co., 1456 Jefferson Ave., Buffalo, N. Y. —6-page folder describing briefly outstanding features and applications of this concern's line of drum and barrel carriers. Illustrated.

Electric Power Systems. General Electric Co., Schenectady, N. Y.—Booklet GED1006—20-page form dealing with quickly installed electric power systems for new plants and plant extensions. Discusses load-center distribution, how it saves time and material. Gives five steps to be followed in the procedure and lists typical specifications for master unit substations, metal-clad switchgear, load-center unit substations, interlocker-armor power cable, lighting transformers, and metal-inclosed, plug-in busway. Well outlined and contains useful engineering charts and layout schemes as well as engineering data in table form. A useful engineer's handy guide on the subject.

Electronic Tubes. General Electric Radio, Television and Electronics Dept., Schenectady, N. Y.—4-page, quick-selection and comprehension chart on electronic tubes for industry, with technical data on applications and tubes. Contains considerable engineering information in chart form. Illustrated.

Equipment. Falstrom Co., Passaic, N. J.—4-page folder illustrating the line of panelboards put out by this concern. Also Bulletin 104, 4-pages illustrating and describing briefly the concern's "barrel-lift" for lifting, moving, tilting and turning barrels, drums and containers up to a capacity of 750 lb. gross.

Equipment. Johnstone Engineering & Machine Co., Downingtown, Pa.—4-page folder illustrating and describing briefly the line of modern slitting, rewinding and uniform tension unwinding machines put out by this concern and used in various war plants. Describes new units put out and summarizes industrial applications.

Equipment Maintenance. The Carrier Corp., Syracuse, N. Y.—24-page booklet entitled "Civilian Conservation of the B.t.u." Intended as a handy reference manual for simple care of air conditioning, refrigerating and heating systems. Described in non-technical terms.

Flowmeters. Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia, Pa.—Catalog N28160—18-page catalog dealing with this concern's "Centrimax" flowmeter for steam and water. Describes outstanding features of the unit, industrial applications, installation, and specifications. Well illustrated.

Fuse Clips. Littelfuse, Inc., 4757 Ravenswood Ave., Chicago, Ill.—Form 10M—4-page folder which announces this concern's new beryllium-copper alloy fuse clip and screw terminals for use in aircraft, electrical and other industry. Includes information on properties, design and construction, screw terminals, and dimension tables as well as diagrammatic drawings.

Gages. Certified Gauge & Instrument Corp., 34-18 Northern Blvd., Long Island City, N. Y.—10-page catalog dealing with this concern's line of pressure, vacuum and compound gages. Each unit is illustrated and discussed. Includes data on specifications and sizes.

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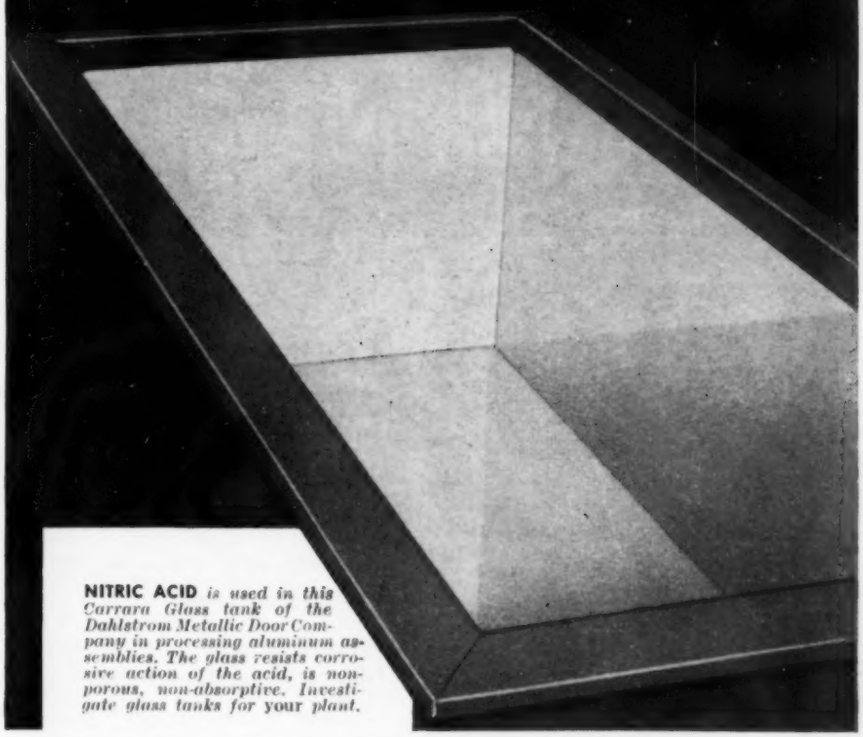

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nelly Iron Sponge & Governor Co., 3154 South California Ave., Chicago, Ill.—4-page pamphlet dealing with preliminary investigations on the value of gasoline for gas-making purposes, such as a gas enricher in place of fuel oil or gas oil. The study was undertaken by request from the Chicago Office of Petroleum Coordinator. Includes a chart giving gas enrichment values of various petroleum products.

Heat Transfer. The International Nickel Co., Inc., 67 Wall St., New York, N. Y.—20-page booklet entitled "Heat Transfer - through Metallic Walls." Discusses, from an engineering viewpoint, overall heat transfer rates anticipated as a result of conductivity through metallic walls, factors influencing such transfer, and affect of this on fabrication of steam chests, condensers, jacketed units, etc. Extensively illustrated. Contains numerous charts showing the effect of wall thickness on heat transfer through various metals.

Heat Treatment. E. I. du Pont de Nemours & Co., Inc., Electrochemical Dept., Wilmington, Del.—72-page spiral-bound notebook entitled "Molten Salt Baths," which deals with the heat treatment and case hardening of steel in baths containing sodium cyanide. Gives useful and complete information on cyanide hardening, cyanide reheating and nitriding, heat treating salts, heat coloring, cyanide disposal, safety measures and first aid, salt bath equipment, analytical methods, etc. Contains extensive engineering information in text, chart and diagram form. Extensively illustrated. An appendix contains tabular information on hardness conversion, temperature conversion and S.A.E. steels. Well organized.

Ignitron Rectifiers. Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.—Booklet B3130—4-page booklet dealing with the application of ignition rectifiers for service in the electrochemical industry. Describes the rectifier and outlines its applications, methods of installation and maintenance.

Insulation. Armstrong Cork Co., Lancaster, Pa.—4-page folder announcing this concern's "Foamglas", new low-temperature insulation material which is vaporproof, fireproof and made of "foamed" glass. Describes properties of the material, its advantages, methods of working and handling, and suggested applications. Well illustrated.

Illuminated Magnification. The Boyer-Campbell Co., 6540 Antoine St., Detroit, Mich.—4-page folder which illustrates and describes briefly this concern's "Super Light" illuminated magnifier for close inspection, fine assembly work, and precision machining and other purposes. Also a pamphlet describing how this unit can be used in hospital and first-aid work.

Machine Tool Accessories. Ideal Commutator Dresser Co., Machinery Products Division, 1278 Park Ave., Sycamore, Ill.—8-page catalog dealing with this concern's machine tool accessories, including live centers, metal etchers, demagnetizers, variable speed pulleys, electric markers, etc. Each unit is illustrated and described briefly. Includes data on specifications and uses.

Manometers. Simplex Valve & Meter Co., 68th and Upland Sts., Philadelphia, Pa.—Bulletin 200—Bulletin describing this concern's line of standard manometers for measurement of air, water, steam, etc. Includes specification details, capacities and method of connection, together with a reference section of useful data.

Open Wiring. Delta-Star Electric Co., 2400 Block Fulton St., Chicago, Ill.—This concern's July-August issue of its house organ which contains a 3-page article on open wiring for speeding war production. Discusses how this system saves time, conserves materials, and reduces manpower. Includes information on flat construction, triangular construction, voltage calculations, cable characteristics and percent voltage drop.

Organic Chemicals. Eastman Kodak Co., Chemical Sales Division, Rochester, N. Y.—List No. 33—140-page, 1942 list of the synthetic organic chemicals put out by this concern. Catalogs more than 3,400 different chemicals primarily intended for use in research, as special reagents, vitamin work, etc. Gives the

melting point or boiling point of each compound and the list price.

Plastics. Durez Plastics & Chemicals, Inc., Walck Road, North Tonawanda, N. Y.—8-page non-technical discussion of the manufacture of plastics from raw materials to finished product. Illustrates and describes manufacturing process, compression molding, and uses of phenolic plastics and resins. Contains information on sources of data.

Power Plant Equipment. The Williams Gauge Co., 2018 Pennsylvania Ave., Pittsburgh, Pa.—Catalog 142—24-page catalog illustrating and giving technical data on this concern's specialties, much as pump valves, water gages, steam pump governors, safety feed water regulators, etc. Each unit is described.

Preventing Coal Fires. Coal Specialties Co., 50 Church Street, New York, N. Y.—4-page folder dealing with the use of this concern's "Hot Spot" indicators to prevent spontaneous combustion in coal piles. Illustrated.

Pumps. DeLaval Steam Turbine Co., Trenton, N. J.—4-page reprint entitled "Pump Design Affords Wide Scope in Application". Includes numerous diagrammatic sketches and charts. Discusses how pump characteristics are affected by features of design and how to predict delivery, head, power requirements and efficiency at different speeds.

Pumps. Milton Roy Pumps, 1300 E. Mermaid Ave., Philadelphia, Pa.—Bulletin 426—2-page sheet entitled "Four Steps Ahead in Pumping Practice" which gives the story of this concern's step-valve for high pressure service, how it works, advantages and similar information.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletin W111B31—4-page folder which deals with this concern's horizontal single piston pumps of the valve plate type for pressures up to 250 lb. per sq. in. Also Bulletin No. W412B40, six pages on horizontal duplex plunger power pumps for general high pressure hydraulic service. Also Bulletin W111B10A, 10-page bulletin on horizontal simplex side pot pumps for refinery service. Each bulletin is illustrated and includes tables of engineering data, dimensional drawings and specifications.

Rotary Pumps. Blackmer Pump Co., Grand Rapids, Mich.—24-page, general catalog on the line of rotary pumps put out by this concern. Discusses briefly basis units, construction and use of various types of pumps in the petroleum, chemical, paint and varnish and allied fields. Also illustrates and describes briefly various types of power pumps, truck pumps, direct-connected pumps, etc.

Spray Nozzles. Chain Belt Co., 1600 W. Bruce St., Milwaukee, Wis.—Bulletin 409—6-page folder which illustrates and describes briefly non-clogging, hard-hitting flat spray nozzles for washing, cleaning, cooling and descaling.

Strainers. Blackmer Pump Co., Grand Rapids, Mich.—Bulletin 400—2-page sheet illustrating and describing briefly this concern's line of "Ezy-Kleen" strainers for protection of all types of pumps. Includes tables on dimensions and cross-sectional drawings.

Strainers. Yarnell-Waring Co., Chestnut Hill, Philadelphia, Pa.—Bulletin S200—4-page folder illustrating and describing briefly the line of fine-screen strainers put out by this concern. Includes data on prices, weights and dimensions as well as cross-sectional drawings.

Switching. General Electric Co., Schenectady, N. Y.—Bulletin GEA3598—16-page booklet dealing with this concern's 65-ton diesel-electric for industrial switching purposes. Describes and illustrates the unit and its acessories and includes engineering data on capacity and specifications.

Tractor Equipment. Trackson Co., Milwaukee, Wis.—Bulletin A-294—8-page folder which illustrates and describes very briefly this concern's line of tractor equipment for industry, including excavators, pipe layers, etc. Includes condensed specification data.

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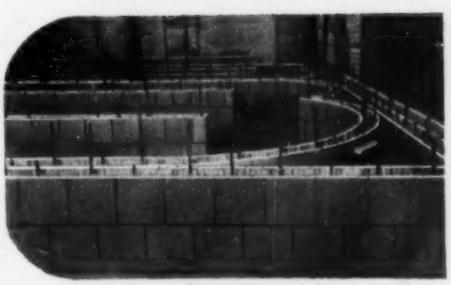
Stebbins Tile Tanks, with their smooth, clean glazed surfaces, are widely used for their durability, cleanliness and economical construction . . . adaptability to limited spaces . . . quick assembly . . . and low maintenance cost.

Stebbins Service — with its many years background of designing and erecting tanks for key industries—will give you proper engineering and skilled installation service, which definitely assures you a satisfactory job to meet today's operating conditions.



SEMCO

Stebbins Engineering and Manufacturing Company

367 EASTERN BLVD. WATERTOWN, N. Y.

Built for Steel Prog

INDUSTRIAL CONSUMPTION OF CHEMICALS MOVES ALONG ON FAIRLY STEADY LINE

CHEM & MET ECONOMICS & MARKETS

TOTAL production and consumption of chemicals continues to expand with military requirements taking a constantly increasing percentage of the output. Industrial consumption of chemicals—meaning consumption in the lines which are not classed as strictly war industries—is going forward on a fairly even keel. In some cases, activities have been sharply lowered as typified by reports from pulp and paper mills. Last year these mills were forced to produce in record volume in order to take care of the orders received but early this year it became evident that the heavy buying had resulted in large inventories and with a slowing up in buying interest the production curve recently has been steadily downward. Production of pulp in July was lower than in any month of 1941 with the exception of February. Petroleum refining in recent months likewise has fallen considerably from peak levels. Glass outputs were curtailed sharply in July and fell below the totals reported for the corresponding month of last year. On the other hand superphosphate production has been stimulated by the scarcity of other fertilizer chemicals and contra-seasonal operations at these plants have tended to make up for the lessened activities in other lines.

With the third quarter of this year well advanced, the position of so-styled industrial consumers becomes clearer and with scarcely an exception the outlook is favorable. Demand for superphosphate promises to be large and acidulators are aided by the fact that they are getting spent sulphuric acid from explosives work. This means that they can operate their sulphuric acid plants at close to optimum efficiency rates instead of at the high overloads previously required. Use of paper and products is large and it is probable that buying activity will assert itself more forceably as stocks in consumers hands become exhausted. Oil refining started to improve last month and when transportation facilities become more normal further gains may be expected. In the glass industry, outlets for plate glass have been narrowed and production undoubtedly will be relatively small for the duration. Window glass and containers, however, have found a ready market and new records are in sight for both branches. While government orders are accounting for a large part of paint production, the loss from the automotive trade is hard to overcome and the outlook for the final months of this year is none too bright.

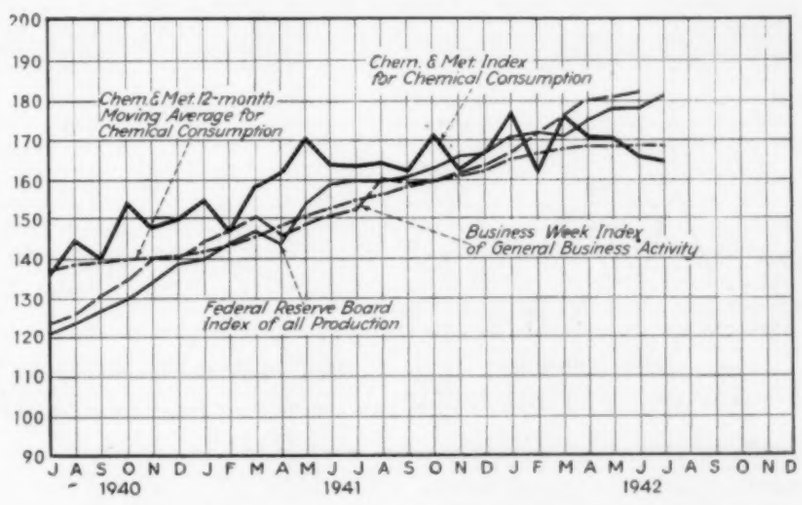
Steel mills are called upon to hold outputs at a maximum and so far as this is possible it will be done with the assurance that demand for chemicals and other raw materials from that direction will continue heavy. The combined military and civilian requirements for textiles is keeping mills in full production and promise to do so for a long time to come. This is equally true for rayon which not only is going directly into war products but also is being used to a larger extent in conjunction with wool and cotton. While sulphate of ammonia has been placed under allocation, July production was unrestricted although shipments from producing plants amounted to only one-third of the output. Some of the plastics are relatively quiet but the industry as a whole is going ahead and certain selections are reported to show gains in output this year of as much as 300 percent.

A summary of present conditions, therefore, indicates that conversion of plants and allocation of raw materials has not very adversely affected the chemical-consuming lines and most of them are in a position to hold current rates of operations or improve them over the remainder of the year.

The index for consumption of chemicals for July is 164.53 compared with 166.56 for June. For July 1941 the index was 163.82 and it rose to 171.48 in October which was the high point for the year. The all-time peak of 177.12 was reached in January of this year and the drop from that figure to the current level is due to the fact that fertilizer production was at its highest in January and conditions within the oil and paper industries have become less favorable in the intervening months.

Chem. & Met. Index for Industrial Consumption of Chemicals

	June	July
Fertilizers	35.04	35.15
Pulp and paper	19.40	17.65
Petroleum refining	13.65	14.42
Glass	16.06	14.64
Paint and Varnish	14.27	13.70
Iron and steel	13.27	13.58
Rayon	14.89	15.28
Textiles	12.26	12.37
Coal products	9.52	9.59
Leather	4.80	4.85
Industrial explosives	6.15	5.90
Rubber	3.00	3.00
Plastics	4.25	4.40
	166.56	164.53

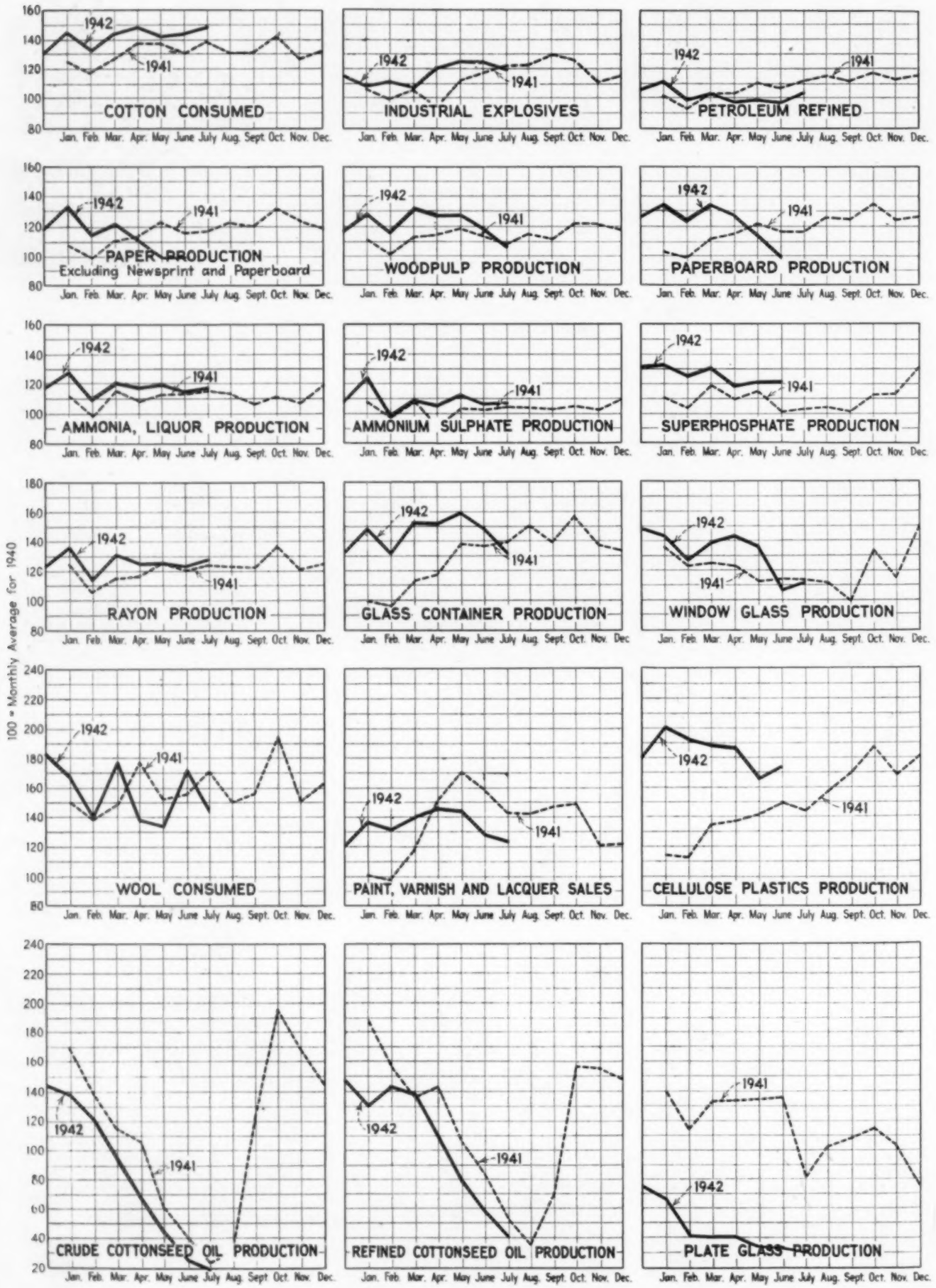


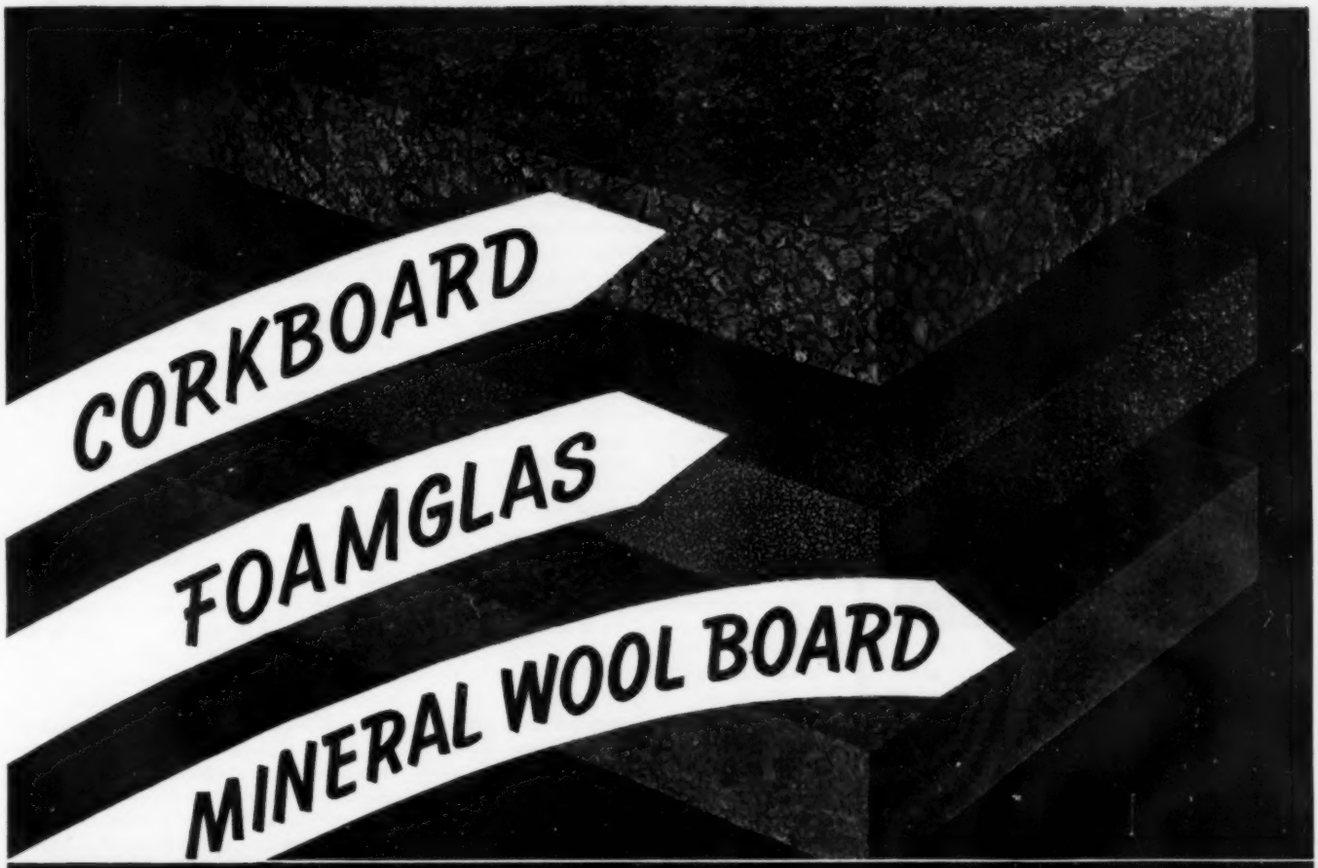
Production and Consumption Data for Chemical-Consuming Industries

	July 1942	July 1941	January-July 1942	January-July 1942	Per cent of gain for 1942
Production					
Ammonia, liquor, 1,000 lb	5,583	5,425	39,086	36,569	6.9
Ammonium sulphate, tons	64,288	62,570	448,178	430,467	4.0
Byproduct coke, 1,000 tons	5,312	5,020	35,929	33,644	6.8
Coal-tar, 1,000 gal	61,847	59,395	430,467	403,944	6.6
Creosote oil, 1,000 gal	3,643	3,115	23,802	20,436	16.5
Glass containers, 1,000 gross	5,946	6,325	46,437	38,071	22.0
Plate glass, 1,000 sq. ft	4,194	12,463	39,108	121,016	67.7*
Window glass, 1,000 boxes	1,274	1,281	10,377	9,642	7.6
Pyroxylin spread, 1,000 lb	4,771	6,473	37,957	47,467	25.1*
Woodpulp, tons	754,573	779,753	6,104,917	5,555,571	9.9
Consumption					
Cotton, bales	995,041	929,782	6,724,035	6,143,096	9.5
Industrial explosives, 1,000 lb	40,409	41,273	274,954	256,043	7.4
Cottonseed oil, bbl	239,933	320,947	1,607,342	2,399,895	33.0*

* Percent of decline.

Production and Consumption Trends





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ARMSTRONG'S CORKBOARD

Cork is high on the Government's list of essential war materials. Hence Armstrong's Corkboard is available only for vital installations. This pure cork material forms an unusually effective barrier to heat's passage—holds low temperatures in close ranges and keeps refrigeration costs at a minimum. Corkboard is light, strong, rigid. Being highly resistant to moisture and to common forms of deterioration, it gives dependable protection for years.

ARMSTRONG'S FOAMGLAS

Foamglas is a brand-new form of glass, made up of thousands of tiny airtight cells. The slight vacuum in these cells forms an efficient heat barrier. Foamglas not only is *waterproof* but even more important, it is *vaporproof*. It keeps its original insulating efficiency permanently. Foamglas has a compressive strength of 130 lbs. per square inch, and is absolutely fireproof, verminproof, and odorless. In addition, Foamglas is light in weight, and can be sawed and worked with ordinary tools. It is a noncritical material made in one size, 12″ x 18″ and in 2″, 3″, 4½″, and 6″ thicknesses.

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This new noncritical material is basically mineral wool with a waterproof binder and is processed into structurally strong boards. These boards can be erected without any supporting members and will stay permanently in place without sagging, settling, shrinking, swelling, or warping. Armstrong's Mineral Wool Board is quickly and easily erected. It has a low thermal coefficient, good moisture-resistance and is free from objectionable odor and from any liability to rot, mold, or harbor vermin. One standard size, 12″ x 36″, and thicknesses from 1″ to 4″ are available.

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NEW PLAN FOR DISTRIBUTION OF SCARCE CHEMICALS AND OTHER MATERIALS FOR FOURTH QUARTER

In the latter part of last month announcement was made by the Director General for Operations to the effect that a new program had been arranged for controlling the flow of materials during the fourth quarter of this year. The announcement stated that for the first time a reasonably complete supply and demand picture of American industry is available. The War Production Board is taking another long step away from simple priorities toward allocation of materials in accordance with the needs of the war program. The basic theory of the program consists in obtaining information about the requirements for the quarter with similar information about the stocks of materials which will be available and then directing the movement of the scarce materials into channels where they are most essential.

The program goes beyond mere distribution, however, as it calls for careful checks to see that all materials authorized and received in the quarter are actually put into production within that period or used to maintain a practicable working minimum inventory. Also checks will be made to determine whether the materials should properly be put into production in the quarter to meet delivery dates essential to the war program. Authorization may be withdrawn if it is found that the products being manufactured are not required until some time after completion even though the goods themselves may be of great military importance.

While this new control system may have but little effect on distribution of the great bulk of chemicals, it is noted that the latest listing of scarce materials places a goodly number of chemicals under the Group I classification. The chemicals which are rated as most critical—acrylonitrile, butadiene, cresols, phenol and derivatives, and toluol and derivatives—evidently will be entirely allocated according to the new plan. Incidentally it may be pointed out that chlorine no longer is placed in Group I which is an indication that production has been increased to a point where most requirements can be filled. As issued, titanium oxide was included in a list of supplementary materials for which inventory restrictions had been released. Later this was corrected by an announcement that titanium oxide had been so listed in error.

Among the new orders in the last month is one calling for complete allocation of aromatic petroleum solvents. The order was issued on Aug. 29 and specified that from that date to Oct. 1, deliveries are limited to those holding preference ratings of A-2 or higher and on and after Oct. 1 no deliveries may be made except as specifically authorized by the Director General for Operations. Another order stipulated that deliveries of more than 1,000 pounds of soluble nitrocellulose a month may be made only by special authorization. Later two changes in this order were announced, one removed restrictions from nitrocellulose suitable for dynamite manufacture and the other took undissolved film scrap out of allocation control.

An order issued June 6 provided that when cobalt-nickel oxide could not be separated into its component metals it might be used for ground coat frit without restrictions. It was found that persons using the oxide were not making a genuine effort to separate the metals and a new order limits the use of cobalt for ground frit, in any one quarter, to 35 percent of the amount used in the first six months of 1941.

Allocation and other authority of WPB has been delegated to Commodity Credit Corp. in respect to vegetable oilseeds and products. This has resulted in an overall program involving prices, marketing and processing to be operated by CCC in connection with this year's crops of soybeans, peanuts, cottonseed, and flaxseed. Under this program, CCC is authorized to purchase and resell vegetable oilseeds and products through contracts with processors, refiners, and bleachers who agree to pay not less than specified prices for oil crops, crude oil and linters. Under this agreement the minimum price paid by processors for cottonseed is $50 a ton in all States except Texas, Oklahoma, and New Mexico where it is $1 a ton less.

Contracts are being made with linseed crushers providing for non-recourse loans to such producers on up to 40 percent of their production from the 1942 domestic flaxseed crop, conditioned on the payment of $2.40 per bushel for No. 1 seed, Minneapolis basis. Details for contracts with crushers of peanuts and soybeans are being worked out and will soon be announced.

Developments of price significance included the order making all distributors selling chemicals or drugs covered by specific price regulations subject to license. In explanation of this order it was stated that because of the importance of the products in question,

CHEM. & MET. Weight Index of CHEMICAL PRICES

Base = 100 for 1937

This month	**109.30**
Last month	109.11
September, 1941	103.42
September, 1940	98.68

Quotations for sulphate of ammonia were brought under a new ceiling level with a slight net advance for the product. Ceilings for normal butyl alcohol, acetone and butyl acetate were sharply lowered but this did not affect the market as these products had not been selling at the figures set in the previous ceilings.

safeguards were adopted to insure price stability and to make certain that there would be no evasion of existing or future price regulations. Another change which made for lower prices was seen in the order which reduced the maximum price for fermentation acetone from 15.8c a lb. to 12½c a lb. Normal fermentation butyl alcohol was cut to the same degree and values for normal fermentation butyl acetate were established at 13½c a lb. or 1c a lb. higher than that for the alcohol. In each case these maximum prices are producer prices in tank cars delivered in eastern territory. Sulphate of ammonia was brought under a new price ceiling on Aug. 17. The base price is $28.20 a ton at inland oven plus the transportation charges to buyers destination or a base price of $29.20 per ton at port plus transportation charges from the port nearest the buyers destination.

From an import angle interest attaches to a ruling made by WPB whereby some 500 items generally imported from all parts of the world were placed on an emergency shipping priorities list. Only items on this list will be assigned space that becomes available ships controlled by the War Shipping Administration which are bound for this country with the exception of lower-rated cargoes from the Caribbean area, the territorial and insular possessions of the United States, the British Isles, Canada and Newfoundland where shipping space that has not been exhausted.

Another stockpile that is being accumulated is that of the high lauric acid vegetable oils. These are under strict allocation even though domestic production will permit an increase in the reserve supply between now and the first of the year. By that time synthetic rubber manufacture will be underway and fear has been expressed that no matter how big the reserve bank the supply will then become inadequate in spite of the fact that the four oil crops—soybeans, peanuts, cottonseed and flaxseed—are expected to amount to 4 billion pounds of vegetable oils this year, an increase of 1.4 billion pounds over last year's production.

CHEM. & MET.
Weighted Index of Prices for
OILS & FATS

Base=100 for 1937

This month	**141.01**
Last month	141.53
September, 1941	127.37
September, 1940	67.43

Placing the oil industry under control of Commodity Credit Corp. is expected to stabilize prices for oilseeds and maintain ceiling prices for oils. Minimum price for flaxseed is set at $2.40 per bu. and for cottonseed $49-50 a ton. Values for cottonseed cake, bulk, are set at $31.50-4.50 a ton and for linseed meal at $30 a ton.

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Works havoc in your pipes, boilers and heat exchangers
BACTERIAL DEPOSIT
2
Makes itself at home and plugs up your pipes and tubes
HOT WATER SCALE
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Fights hard to keep you from getting water necessary for production
OILY BOILER DEPOSIT
4
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The Glucosates conserve energy also. Less fuel is needed and more production obtained where the Glucosates control scale, corrosion and living organisms.

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FACTS and FIGURES
of
AMERICAN CHEMICAL INDUSTRY

★Reprinted from *Chem. & Met's* February 1942 issue, wherein the editors presented a 40-page public accounting of the economic and technical status of the nation's most important industry. It is addressed to everybody because we are all stockholders, customers and/or employees in this billion dollar business that in 1942 topped all production records.

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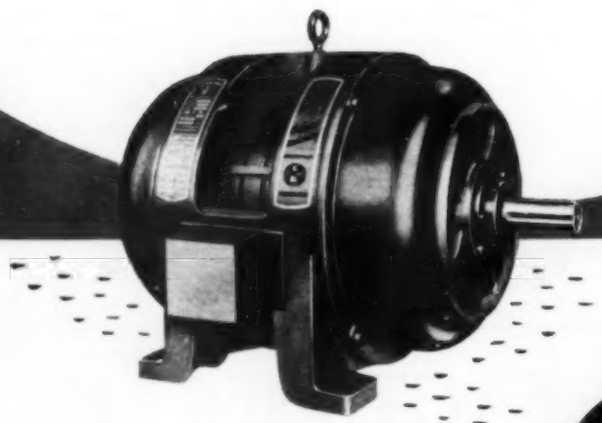

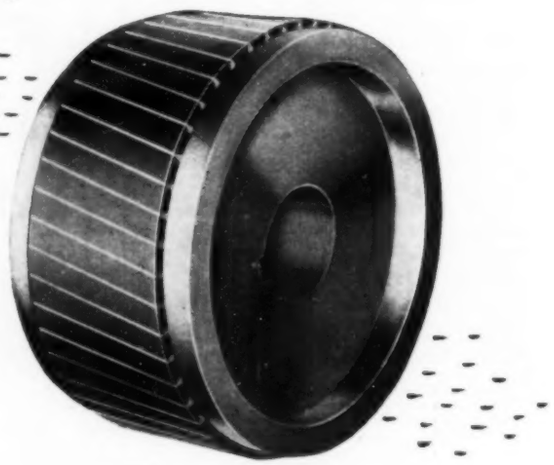

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CHEM & MET CURRENT PRICES

INDUSTRIAL CHEMICALS

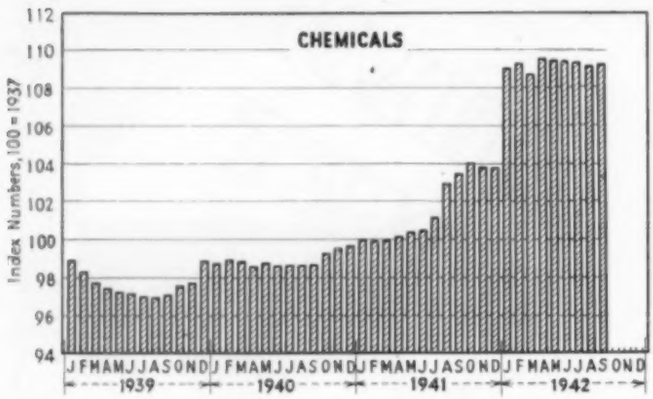
	Current Price	Last Month	Last Year
Acetone, drums, lb	$0.135–$0.168	$0.168–$0.173	$0.08½–$0.09
Acid, acetic, 28%, bbl., cwt	3.38 – 3.63	3.38 – 3.63	3.18 – 3.43
Glacial 99.5%, drums	9.15 – 9.40	9.15 – 9.40	8.68 –10.00
U. S. P. X 1, 99.5%, dr	10.95 –11.20	10.95 –11.20	10.50 –11.00
Boric, bbl., ton	108.00–113.00	108.00–113.00	106.00–111.00
Citric, kegs, lb	.20 – .23	.20 – .23	.20 – .23
Formic, cbys., lb	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb	1.10 – 1.15	1.10 – 1.15	1.05 – 1.15
Hydrofluoric 30% drums, lb	.08 – .08½	.08 – .08½	.08 – .08½
Lactic, 44%, tech., light, bbl., lb	.073– .075	.073– .075	.06½– .06¾
Muriatic 18°, tanks, cwt	1.05 –	1.05 –	1.05 –
Nitric, 36°, carboys, lb	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –	18.50 –20.00
Oxalic, crystals, bbl., lb	.11½– .13	.11½– .13	.10½– .12
Phosphoric, tech., c'bys., lb	.07½– .08½	.07½– .08½	.07½– .08½
Sulphuric, 60°, tanks, ton	13.00 –	13.00 –	13.00 –
Sulphuric, 66°, tanks, ton	16.50 –	16.50 –	16.50 –
Tannic, tech., bbl., lb	.71 – .73	.71 – .73	.64 – .66
Tartaric, powd., bbl., lb	.70 –	.70 –	.63 –
Tungstic, bbl., lb	nom	nom	nom
Alcohol, amyl	–	–	–
From Pentane, tanks, lb	.131–	.131–	.121–
Alcohol, Butyl, tanks, lb	.158–	.158–	.10 –
Alcohol, Ethyl, 190 p'f., bbl., gal	8.19 – 8.25	8.19 – 8.25	6.04 –
Denatured, 190 proof	–	–	–
No. 1 special, dr., gal. wks	.60 –	.60 –	.33 –
Alum, ammonia, lump, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Potash, lump, bbl., lb	.04 – .04¼	.04 – .04¼	.04 – .04¼
Aluminum sulphate, com. bags, cwt	1.15 – 1.40	1.15 – 1.40	1.15 – 1.40
Iron free, bg., cwt	1.85 – 2.10	1.85 – 2.10	1.85 – 2.10
Aqua ammonia, 26°, drums, lb	.02¼– .03	.02¼– .03	.02½– .03
tanks, lb	.02 – .02¼	.02 – .02½	.02 – .02½
Ammonia, anhydrous, cyl., lb	.16 –	.16 –	.16 –
tanks, lb	.04¼–	.04¼–	.04¼–
Ammonium carbonate, powd. tech., casks, lb	.09½– .12	.09½– .12	.09 – .12
Sulphate, wks., ton	29.20 –	29.00 –	29.00 –
Amylacetate tech., from pentane, tanks, lb	.145–	.145–	.115–
Antimony Oxide, bbl., lb	.15 –	.15 –	.13 –
Arsenic, white, powd., bbl., lb	.04 – .04¼	.04 – .04¼	.04 – .04½
Red, powd., kegs, lb	nom	nom	nom
Barium carbonate, bbl., ton	60.00 –65.00	60.00 –65.00	55.00 –60.00
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb	.11 – .12	.11 – .12	.09½– .10
Blanc fix, dry, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt	2.25 – 2.35	2.25 – 2.35	2.00 – 2.10
Borax, gran., bags, ton	44.00 –	44.00 –	43.00 –
Bromine, cs., lb	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	3.00 –	3.00 –	3.00 –
Arsenate, dr., lb	.07 – .08	.07 – .08	.07½– .07¾
Carbide drums, lb	.04½– .05	.04½– .05	.04½– .05
Chloride, fused, dr., del., ton	18.00 –24.00	18.00 –24.00	19.00 –24.50
flake, bags., del., ton	18.50 –25.00	18.50 –25.00	20.50 –25.00
Phosphate, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb	.05½–	.05½–	.05 –
Tetrachloride drums, gal	.73 – .80	.73 – .80	.73 – .80
Chlorine, liquid, tanks, wks., 100 lb	2.00 –	2.00 –	2.00 –
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb	1.84 – 1.87	1.84 – 1.87	1.84 – 1.87
Copperas, bgs., f.o.b., wks., ton	18.00 –19.00	18.00 –19.00	18.00 –19.00
Copper carbonate, bbl., lb	.18 – .20	.18 – .20	.18 – .20
Sulphate, bbl., cwt	5.15 – 5.40	5.15 – 5.40	5.00 – 5.25
Cream of tartar, bbl., lb	.57 –	.57 –	.52 –
Diethylene glycol, dr., lb	.14 – .15½	.14 – .15½	.22 – .23
Epsom salt, dom., tech., bbl., cwt	1.90 – 2.00	1.90 – 2.00	1.90 – 2.00
Ethyl acetate, drums, lb	.12 –	.12 –	.08½–
Formaldehyde, 40%, bbl., lb	.05½– .06	.05½– .06¼	.05½– .06
Furfural, tanks, lb	.09 –	.09 –	.09 –
Fusel oil, drums, lb	.18 – .19	.18 – .19	.17½– .19
Glaubers salt, bags, cwt	1.05 – 1.10	1.05 – 1.10	1.05 – 1.10
Glycerine, c.p., drums, extra, lb	.18¼–	.18¼–	.14½–
Lead:			
White, basic carbonate, dry casks, lb	.08½–	.08½–	.07½–
White, basic sulphate, sck., lb	.07¼–	.07¼–	.07½–
Red, dry, sck., lb	.09½– .09¾	.09½–	.0835–
Lead acetate, white crys., bbl., lb	.12½– .13	.12½– .13	.12 – .13
Lead arsenate, powd., bag, lb	.11 – .12	.11 – .12	.09½– .11
Lime, chem., bulk, ton	8.50 –	8.50 –	8.50 –
Litharge, powd., csk., lb	.08½–	.08½–	.0735–
Lithopone, bags, lb	.04¼– .04½	.04¼– .04½	.038– .04
Magnesium carb., tech., bags, lb	.06¼– .06½	.06¼– .06½	.06¼– .06½
Methanol, 95%, tanks, gal	.60 –	.60 –	.73 –
97%, tanks, gal	.60 –	.60 –	.75 –
Synthetic, tanks, gal	.28 –	.28 –	.30 –
Nickel salt, double, bbl., lb	.13½– .13¾	.13½– .13¾	.13½–
Orange mineral, csk., lb	.12½–	.12½–	.11½–
Phosphorus, red, cases, lb	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb	.18 – .25	.18 – .25	.18 – .25
Potassium bichromate, casks, lb	.09½– .10	.09½– .10	.09½– .10
Carbonate, 80–85%, calc. csk., lb	.06½– .07	.06½– .07	.06½– .07
Chlorate, powd., lb	.10 – .12	.10 – .12	.10 – .12
Hydroxide (c'stic potash) dr., lb	.07 – .07¼	.07 – .07¼	.07 – .07¼
Muriate, 60% bags, unit	.53½–	.53½–	.53½–
Nitrate, bbl., lb	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb	.19½– .20	.19½– .20	.19½– .20
Prussiate, yellow, casks, lb	.17 – .18	.17 – .18	.17 – .18
Sal ammoniac, white, casks, lb	.0515– .06	.0515– .06	.0515– .06
Salsoda, bbl., cwt	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	17.00 –	17.00 –	17.00 –
Soda ash, light, 58%, bags, contract, cwt	1.05 –	1.05 –	1.05 –
Dense, bags, cwt	1.10 –	1.10 –	1.10 –
Soda, caustic, 76%, solid, drums, cwt	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, del., bbl., lb	.05 – .06	.05 – .06	.04½– .05
Bicarbonate, bbl., cwt	1.70 – 2.00	1.70 – 2.00	1.70 – 2.00
Bichromate, casks, lb	.07½– .08	.07½– .08	.07½– .08
Bisulphate, bulk, ton	16.00 –17.00	16.00 –17.00	16.00 –17.00
Bisulphite, bbl., lb	.03 – .04	.03 – .04	.03 – .04
Chlorate, kegs, lb	.06½– .06½	.06½– .06½	.06½– .06¼
Cyanide, cases, dom., lb	.14 – .15	.14 – .15	.14 – .15
Fluoride, bbl., lb	.08 – .09	.08 – .09	.08 – .09
Hyposulphite, bbl., cwt	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt	2.50 – 2.65	2.50 – 2.65	2.35 – 2.40
Nitrate, bulk, cwt	1.35 –	1.35 –	1.47 –
Nitrite, casks, lb	.06½– .07	.06½– .07	.06½– .07
Phosphate, tribasic, bags, lb	2.70 –	2.70 –	2.35 –
Prussiate, yel. drums, lb	.10½– .11	.10½– .11	.10½– .11
Silicate (40° dr.), wks., cwt	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr. lb	.03 – .03½	.03 – .03½	.03 – .03½
Sulphite, crys., bbl., lb	.02¼– .02½	.02¼– .02½	.02¼– .02½
Sulphur, crude at mine, bulk, ton	16.00 –	16.00 –	16.00 –
Chloride, dr., lb	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt	1.90 – 2.40	1.90 – 2.40	1.60 – 3.00
Tin Oxide, bbl., lb	.55 –	.55 –	.55 –
Crystals, bbl., lb	.39½–	.39½–	.39½–
Zinc, chloride, gran., bbl., lb	.05½– .06	.05 – .06	.05 – .06
Carbonate, bbl., lb	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb	.33 – .35	.33 – .35	.33 – .35
Dust, bbl., lb	.10½–	.10½–	.09½–
Zinc oxide, lead free, bag, lb	.07½–	.07½–	.06½–
5% leaded, bags, lb	.07½–	.07½–	.06½–
Sulphate, bbl., cwt	3.85 – 4.00	3.85 – 4.00	3.15 – 3.25

OILS AND FATS

	Current Price	Last Month	Last Year
Castor oil, No. 3 bbl., lb	$0.13½–$0.14¼	$0.13½–$0.14¼	$0.11½–$0.12
Chinawood oil, bbl., lb	.38 –	.38 –	.34 –
Coconut oil, Ceylon, tank, N. Y., lb	nom	nom	.07½–
Corn oil crude, tanks (f.o.b. mill), lb	.12½–	.12½–	.11½–
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.12½–	.12½–	.12½–
Linseed oil, raw car lots, bbl., lb	.133–	.133–	.113–
Palm, casks, lb	.09 –	.09 –	.08 –
Peanut oil, crude, tanks (mill), lb	.12½–	.12½–	.11½–
Rapeseed oil, refined, bbl., lb	nom	nom	.15½–
Soya bean, tank, lb	.11½–	.11½–	.09½–
Sulphur (olive foots), bbl., lb	.19½–	.19½–	.16 –
Cod, Newfoundland, bbl., gal	nom	nom	nom
Menhaden, light pressed, bbl., lb	.114–	.114–	.106–
Crude, tanks (f.o.b. factory) gal	.66 –	.66 –	.60 –
Grease, yellow, loose, lb	.08½–	.09295–	.08½–
Oleo stearine, lb	.09½–	.09½–	.09½–
Oleo oil, No. 1	.11½–	.11½–	.11½–
Red oil, distilled, dp.p. bbl., lb	.11½–	.12 –	.10½–
Tallow extra, loose, lb	.08¾–	.08¾–	.08½–

The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to September 14

Chem. & Met.'s Weighted Price Indexes


CHEMICALS
Index Numbers, 100 = 1937
112
110
108
106
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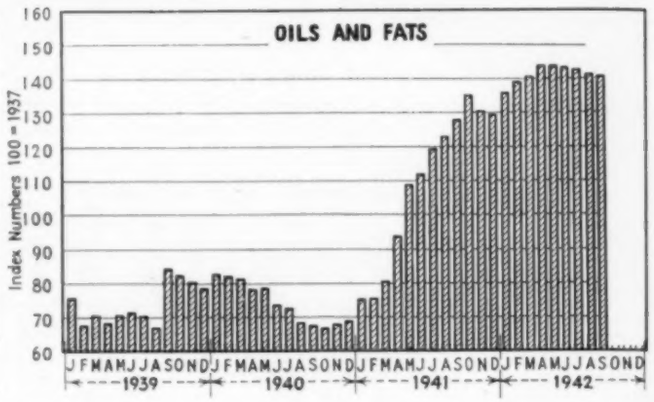
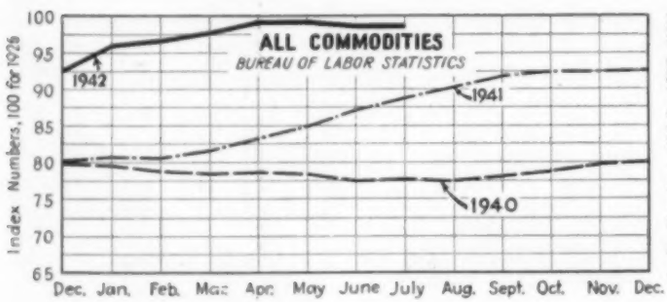
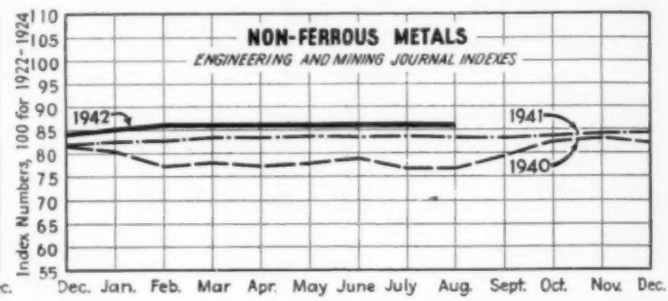






Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb.	$0.52– $0.55	$0.52 –$0.55	$0.52 –$0.55
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.15 – .16	.15 – .16	.15 – .16
Aniline, salts, bbl., lb.	.22 – .24	.22 – .24	.22 – .24
Benzaldehyde, U.S.P., dr., lb.	.85 – .95	.85 – .95	.85 – .95
Benzidine base, bbl., lb.	.70 – .75	.70 – .75	.70 – .75
Benzoic acid, U.S.P., kgs., lb.	.54 – .56	.54 – .56	.54 – .56
Benzyl chloride, tech., dr., lb.	.23 – .25	.23 – .25	.23 – .25
Benzol, 90%, tanks, works, gal.	.15 –.....	.15 –.....	.14 –.....
Beta-naphthol, tech., drums, lb.	.23 – .24	.23 – .24	.23 – .24
Cresol, U.S.P., dr., lb.	.11 –.....	.11 – .11	.10½– .10¾
Cresylic acid, dr., wks., gal.	.81 – .83	.81 – .83	.76 – .78
Diethylaniline, dr., lb.	.40 – .45	.40 – .45	.40 – .45
Dinitrophenol, bbl., lb.	.23 – .25	.23 – .25	.23 – .25
Dinitrotoluol, bbl., lb.	.18 – .19	.18 – .19	.18 – .19
Dip oil, 15%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, dr. f.o.b. wks., lb.	.60 –.....	.60 –.....	.....
H-acid, bbl., lb.	.45 – .50	.45 – .55	.45 – .50
Naphthalene, flake, bbl., lb.	.07 – .07¼	.07 – .07¼	.07 – .07¼
Nitrobenzene, dr., lb.	.08 – .09	.08 – .09	.08 – .09
Para-nitraniline, bbl., lb.	.47 – .49	.47 – .49	.47 – .49
Phenol, U.S.P., drums, lb.	.13 –.....	.13 –.....	.12½–.....
Picric acid, bbl., lb.	.35 – .40	.35 – .40	.35 – .40
Pyridine, dr., gal.	1.70 – 1.80	1.70 – 1.80	1.70 – 1.80
Resorcinol, tech., kegs., lb.	.75 – .80	.75 – .80	.75 – .80
Salicylic acid, tech., bbl., lb.	.33 – .40	.33 – .40	.33 – .40
Solvent napths, w.w., tanks, gal.	.27 –.....	.27 –.....	.27 –.....
Tolidine, bbl., lb.	.86 – .88	.86 – .88	.86 – .88
Toluol, drums, works, gal.	.33 –.....	.33 –.....	.32 –.....
Xylol, com., tanks, gal.	.26 –.....	.26 –.....	.26 –.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech, bbl., lb.	.18 – .19	.15 – .17	.29 – .31
China clay, dom., f.o.b. mine, ton.	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors			
Carbon gas, black (wks.), lb.	.0335– .30	.0335– .30	.0335– .30
Prussian blue, bbl., lb.	.36 – .37	.36 – .37	.36 – .37
Ultramarine blue, bbl., lb.	.11 – .26	.11 – .26	.11 – .26
Chrome green, bbl., lb.	.21½– .30	.21½– .30	.21½– .30
Carmine, red, tins, lb.	4.60 – 4.75	4.60 – 4.75	4.60 – 4.75
Para toner, lb.	.75 – .80	.75 – .80	.75 – .80
Vermilion, English, bbl., lb.	3.05 – 3.10	3.05 – 3.10	3.20 – 3.25
Chrome yellow, C.P., bbl., lb.	.14½– .15½	.14½– .15½	.14½– .15½
Feldspar, No. 1 (f.o.b.N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.08 – .10	.08 – .10	.08 – .10
Gum copal Congo, bags, lb.	.09 – .30	.09 – .30	.08 – .30
Manila, bags, lb.	.09 – .15	.09 – .14	.09 – .14
Demar, Batavia, cases, lb.	.10 – .22	.10 – .20	.10 – .22
Kauri, cases, lb.	.18 – .60	.18 – .60	.18 – .60
Kieselguhr (f.o.b. mines), ton.	7.00 –40.00	7.00 –40.00	7.00 –40.00
Magnesite, calc, ton.	64.00 –.....	65.00 –.....	65.00 –.....
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	nom	nom	.03 – .04
Rosin, H., 100 lb.	3.85 –.....	3.41 –.....	3.12 –.....
Turpentine, gal.	.64½–.....	.61 –.....	.81 –.....
Shellac, orange, fine, bags, lb.	.39 –.....	.39 –.....	.38 –.....
Bleached, bonedry, bags, lb.	.39 –.....	.39 –.....	.35 –.....
T. N. Bags, lb.	.31 –.....	.31 –.....	.28 –.....
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc. 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
200 mesh (f.o.b. Ga.), ton.	6.00 – 8.00	6.00 – 8.00	7.50 –11.00

Industrial Notes

MICHIGAN ALKALI CO., Wyandotte, has moved its general sales offices from the Ford Bldg., Detroit to Wyandotte.

PITTSBURGH PLATE GLASS CO., Pittsburgh, announces that K. C. Frazier has been appointed district sales manager of the New York metropolitan area for the Columbia Chemical Division.

JAS. P. MARSH CORP., Chicago, has changed the name of its subsidiary, the E. A. Hill Co., Inc., to the Dependable Mfg. Co.

YORK ICE MACHINERY CORP., York, Pa., has appointed Ralph B. Meisenhelder as director of war contract progress. The Pittsburgh office of the corporation has been moved to 7 Ferry St.

VICTOR CHEMICAL WORKS, Chicago, has named Rainsford F. Cotton manager of its office in New York.

COCHRANE CORP., Philadelphia, has appointed the Energy Control Co. of the same city, its representative for eastern Pennsylvania, southern New Jersey, Delaware, and Maryland.

WESTVACO CHLORINE PRODUCTS CORP., New York, has added John H. Karrh to its sales organization.

PITTSBURGH PIPING & EQUIPMENT CO., Pittsburgh, has elected Chas. R. Rall chairman of the board; L. K. Hamilton, president; Karl F. Tiegel, vice-president; Jos. G. Gardner, secretary; Chas. R. Rall, treasurer; G. S. Larsen, chief engineer, and F. J. Hays, assistant-treasurer.

FERRO ENAMEL CORP., Cleveland, has authorized the acquisition of all outstanding stock of W. B. Lawson, Inc. The latter company will continue to be conducted under Mr. Lawson's direction.

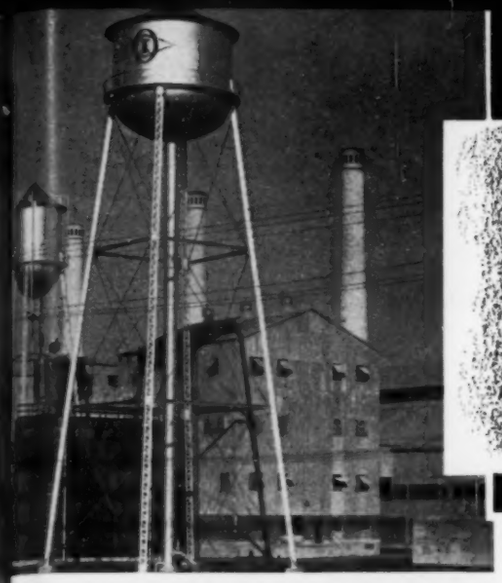
WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, has created a new maintenance sales department for the company's Pacific Coast District and has appointed Hugo E. Becker supervisor.

GOLWYNNE CHEMICALS CORP., New York, has added A. Brothman and A. P. Weber to the engineering staff of its division the Chemurgy Design Corp.

THE RHEEM MFG. CO., Baltimore, has moved its research division from Sparrow Point to 1209 East 25th St., Baltimore. Dr. R. M. Thomas is in charge of the research work.

SHERWIN-WILLIAMS CO. has moved its New York offices from 292 Madison Ave. to 295 Madison Ave.

MURALO CO., Staten Island, has transferred L. R. Oest from the position of purchasing agent to that of plant superintendent and has named C. R. Davison chief chemist in charge of research and development.



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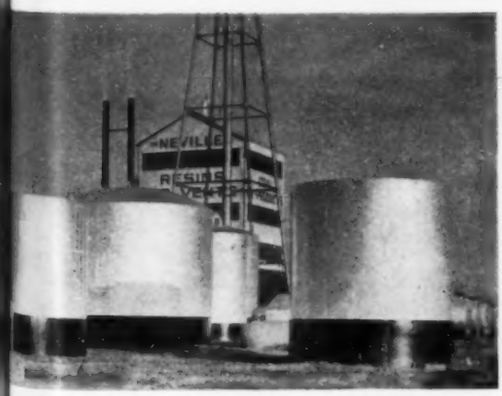
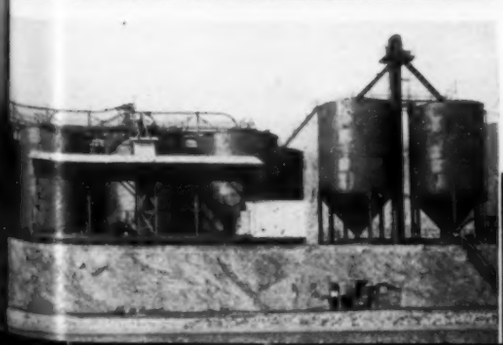
. . . FOUR IMPORTANT ways in which this organization is helping to conserve materials, manpower, time and space in today's All-for-Victory program.





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CHEM & MET NEW CONSTRUCTION

	Current Projects		Cumulative 1942	
	Proposed Work	Contracts	Proposed Work	Contracts *
New England	.....	$715,000	$2,630,000	$4,260,000
Middle Atlantic	.....	36,840,000	6,961,000	107,981,000
South	.....	300,000	11,345,000	71,213,000
Middle West	40,000	90,000	91,555,000	159,915,000
West of Mississippi	250,000	33,880,000	184,717,000	358,830,000
Far West	.....	.....	20,640,000	136,682,000
Canada	2,577,000	1,119,000	14,320,000	2,537,000
	$2,867,000	$72,944,000	$332,168,000	$841,418,000

* Revised total figure for August $769,649,000.

PROPOSED WORK

Ia., Cedar Rapids—Klinger Wall Paper & Paint Co., 117 Second Ave., S. E., plans the construction of a factory. Estimated cost $100,000.

Tex., Decatur—Texas Chemurgic Industries, Inc., plans to rebuild the dehydrating plants here recently destroyed by fire. Estimated cost $50,000.

Tex., Sweeney—Abercrombie Oil Co., Gulf Bldg., Houston, will soon receive bids for additions to its plant including laboratory, gas storage buildings, etc. Estimated cost $100,000.

Wis., Mellen—Penokee Veneer Co., Mellen, plans to rebuild its factory.

Alberta—Department of Munitions & Defense, Ottawa, Ont., Can., plans to construct a gasoline plant. Estimated cost $1,000,000.

Ontario—Provincial Government, Toronto, Ont., Can., contemplates the development of lignite deposits in Northern Ontario to include the construction of plants at various locations. Estimated cost $1,000,000.

Ont., Mount Denis—Dominion Cellulose Co., Ltd., 347 Bay St., Toronto, Ont., plans to construct a plant.

Ont., Toronto—Ajax Tungsten & Molybdenite Mines, Ltd., c/o J. D. Reilly, 112 Yonge St., plans to construct a plant. Estimated cost $60,000.

Ont., Toronto—Perth Mica, Ltd., c/o J. F. Boland, 217 Bay St., plans to construct a plant. Estimated cost $40,000.

Ont., Toronto—Vapour Proof Products, Ltd., c/o L. B. Campbell, Sterling Tower Bldg., plans the construction of a plant. Estimated cost $50,000.

Que., Benneterre—Syndicate c/o J. Bilodeau, Mayor, plans to construct a pulp and paper plant. Estimated cost $200,000.

Que., Three Rivers—Wayagamack Pulp & Paper Co., Ltd., Sun Life Bldg., Montreal, plans to construct repairs to its pulp and paper plant at Three Rivers. Estimated cost $50,000.

Que., Ville La Salle (Montreal)—Distillers Corp., Ltd., Lafleur Ave., will soon receive bids for alterations to its plant. B. R. Perry, 620 Cathcart St., Montreal, Engr. Estimated cost $136,500.

CONTRACTS AWARDED

Arkansas—Project Five Pipe Line Corp. has awarded the contract for a 150 mi. pipe line from Eldorado to Helena, also five pumping stations, to Premier Oil Refining Co. of Texas, Gulf Refining Co., 17 Battery Pl., New York, N. Y. Socony-Vacuum Oil Co., Inc., 230 Park Ave., New York, Texas Co., 135 East 42nd St., New York and Lion Oil Refining Co., Eldorado. Estimated cost $3,500,000.

Mass., Chicopee Falls—Fisk Tire Div. of U. S. Rubber Co., 154 Grove St., has awarded the contract for the construction of a factory to Ley Construction Co., 1215 Main St., Springfield.

Mass., Hingham—U. S. Government has awarded the contract for the construction of a plant here to be leased to Air Reduction Sales Co., 60 East 42nd St., New York, N. Y., to James S. Mozzicato, 168 Mystic Ave., Medford, Mass. Estimated Cost $600,000.

N. J., Bayonne—General Cable Co., 243 West First St., has awarded the contract for alterations and additions to its laboratory to H. K. Ferguson Co., 205 West 43rd St., New York, N. Y. Estimated cost $150,000.

N. J., Maywood—Maywood Chemical Co., 100 Hunter St., has awarded the contract for the construction of a 1 story plant to the Ferber Co., 16 Johnson Ave., Hackensack, N. J. Estimated cost $40,000.

N. J., Newark—Verona Chemical Co., 26 Verona Ave., Newark, has awarded the contract for repairs and alterations to its factory to Maintenance Engineering Co., 46 Willett St., Bloomfield. Estimated cost $150,000.

O., Cleveland—Monarch Aluminum Manufacturing Co., R. Deutsch, Pres., 9301 Detroit Ave., has awarded the contract for a 1 story, 70x204 ft. plant to H. L. Vokes Co., 5300 Chester Ave. Estimated cost $50,000.

Oklahoma—Continental Oil Co., Ponca City, will construct two plants. Work will be done by force account. Estimated cost $2,400,000 and $2,600,000 respectively.

Pennsylvania—Climax Molybdenum Corp., M. W. Murphy, Supt., Langeloth, has awarded the contract for engineering, construction and management services for an addition to its plant to Rust Engineering Co., Clark Bldg., Pittsburgh. Estimated cost $500,000.

Pennsylvania—U. S. War Dept., 26th St. and Constitution Ave., Washington, D. C., has awarded the contract for the construction of an ordnance manufacturing plant to Fraser-Brace & Co., 10 East 40th St., New York, N. Y. Estimated cost $33,000,000.

Pennsylvania—U. S. Government, Wash., D. C., has awarded the contract for a chemical manufacturing plant to W. E. Wood Co., 4649 Humboldt St., Detroit, Mich. Estimated cost less than $3,000,000.

R. I., Bristol—U. S. Rubber Co., 500 Wood St., has awarded the contract the contract for alterations and additions to its plant to Central Engineering & Construction Co., 210 Main St., Pawtucket. Estimated cost $75,000.

Tennessee—U. S. Engineer, U. S. Courthouse, Nashville, has awarded the contract for the construction of a plant to Hercules Powder Co., Delaware Trust Bldg., Wilmington, Del. Estimated cost between $100,000 and $500,000.

Texas—Dow Chemical Co., Midland, Mich., has awarded the contract for the construction of a plant to Stone & Webster, Inc., 49 Federal St., Boston, Mass. Estimated cost $18,000,000.

Texas—Goodrich Rubber Co., Akron, O., has awarded the contract for the construction of a plant to Tellepsen Construction Co., 3910 Clay St., Houston. Estimated cost $10,000,000.

Tex., Clarkwood—G. Claymore, Milam Bldg., San Antonio, Tex., will construct a refinery here. Work will be done by owner. Estimated cost $40,000.

Tex., Corpus Christi—American Cyanamid Corp., 535 Fifth Ave., New York, N. Y., has awarded the contract for the construction of a plant to Chemical Construction Co., New York, N. Y., and Corpus Christi. Estimated cost $500,000.

Tex., Borger—Phillips Petroleum Co. will construct storage facilities at its plant here. Work will be done by force account. Estimated cost $90,000.

Tex., Texas City—Pan American Refining Corp., Texas City, will construct additions to its plant. Work will be done by day labor. Estimated cost $50,000.

Texas and Louisiana—Humble Pipe Line Co., Texas Pipe Line Co., Pure Transportation Co., Crown Central Pipe Line & Transportation Corp., Pan American Pipe Line Co. and Shell Pipe Line Corp., Box 2648, Houston, Tex., have awarded the contract for a 10 in. pipe line from Port Neches, Tex., to Baton Rouge, La., to I. C. Little, Gulf States Bldg., Dallas; 8 in. line from Baytown to Port Neches to O. R. Smith, Odessa, La. Estimated cost $7,000,000.

Texas-Oklahoma—Texas Pipe Line Co., c/o West Dallas Refinery, Dallas, has awarded the contract for laying 30½ mi. and 8¾ mi. of 8 in. steel welded joint pipeline between Armstrong and Colgate, and 35 mi. between Sherman and Armstrong Sta., N., Tex., to N. A. Saigh Construction Co., Builders Exchange Bldg., San Antonio, at approximately $105,000 $32,000 and $120,000 respectively; 39 mi. between Dallas and McKinney, Tex., to W. G. Hanrahan, c/o owners, estimated cost $135,000.

Wis., Racine—B. D. Eisendrath Tanning Co., 702 Racine St., has awarded the contract for the construction of a 1 story, 66x181 ft. factory addition to Nelson & Co., Inc., 1550 Yont St.

N. S., Shelburne—Vitamin Products, Ltd., Shelburne, plans to construct a plant. Work will be done by day labor. Estimated cost $40,000.

Ont., Niagara Falls—Canadian Carborundum Co., Stanley St., will construct additions to its plant. Work will be done with own forces. Estimated cost $500,000.

Ont., Thorold—Ontario Paper Co., Ltd., Allenburg Rd., has awarded the contract for the construction of a plant to Aiken & McLachlan, Ltd., 9 Queen St., St. Catherines. Estimated cost $386,000.

Ont., Welland—Electro Metallurgical Co., Main St., plans to construct a plant. Work will be done with own forces.

Que., Montreal—Sherwin-Williams Co., of Canada, Ltd., 2875 Centre St., has awarded the contract for reconstructing its linseed oil plant to the Foundation Co. of Canada, Ltd., 1538 West Sherbrooke St. Estimated cost $50,000.

Que., Temiskaming—Canadian International Paper Co., Ltd., H. A. Leblanc, Secy., South Temiskaming, has awarded the contract for the construction of a pulp storage building, etc., to Bennett-Pratt, Ltd., 30 Bloor St., W., Toronto, Ont. Estimated cost $45,000.

Que., Ville LaSalle—J. B. Williams & Co. of Canada, Ltd., 9471 LaSalle Blvd., has awarded the contract for the construction of a glycerine evaporating plant to W. H. Madigan, 2165 Clinton St., Montreal, at $57,500.